Town and Window Gardening

BUCKTON

TOWN AND WINDOW GARDENING

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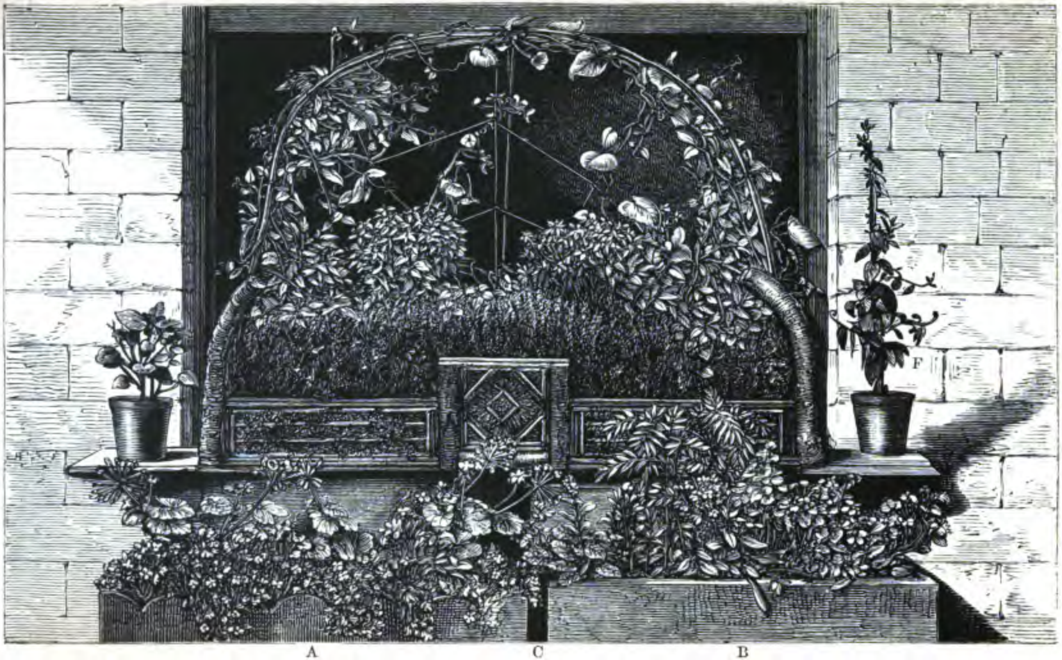

The Window Boxes A and B gained the two First Prizes. The centre Box C gained the First Pupil Teacher's Prize.
F, Fuchsia that gained a Prize.

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TOWN AND WINDOW GARDENING

INCLUDING THE

STRUCTURE, HABITS, AND USES OF PLANTS

A Course of Sixteen Lectures

GIVEN OUT OF SCHOOL HOURS TO PUPIL-TEACHERS AND CHILDREN ATTENDING THE LEEDS BOARD SCHOOLS

BY

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LONDON

LONGMANS, GREEN, AND CO.

1879

To Grace Ashburner.
with her Cousin.
Catherine M. Buckton's love
June 21-1880

DEDICATION

THIS LITTLE BOOK IS DEDICATED TO

DEAN STANLEY

IN GRATEFUL RECOGNITION OF HIS UNWEARIED EFFORTS TO RAISE THE TASTES OF THE PEOPLE; AND TO THE MEMORY OF

LADY AUGUSTA STANLEY

AS A TRIBUTE OF RESPECT AND ADMIRATION FOR THE PRACTICAL INTEREST SHE TOOK IN 'WINDOW GARDENS,' WHICH DID SO MUCH TO BRIGHTEN THE HOMES OF THE POOR IN WESTMINSTER AND TO INSPIRE LITTLE CHILDREN WITH A LOVE OF FLOWERS

PREFACE.

THIS little book owes its existence to my having offered prizes for window garden-boxes about three years ago to children from the Leeds Board Schools, who attended my lectures on the 'Laws of Health.' The two years' experience, in awarding these prizes, showed me that window gardens are very difficult gardens, and that it is impossible for children or men to become good gardeners unless they understand the structure, nature, and growth of plants. Failing to find an *easy* book with the information I thought necessary, I studied the more scientific authorities, procured at Paris Dr. Auzoux's beautiful models of plants, and then gave the following Lectures during the next twelve months.

At the close of the instruction, I occasionally gave a practical lesson on gardening, by preparing the soïl and drainage in the box or flower-pot, and by sowing seeds, or planting cuttings, bulbs, &c. Though I laid down a strict rule that no prize could be honourably claimed unless the plant had been set and nurtured by the child itself, still it was not intended to prevent a teacher or parent showing, as I did, the best methods by which the growth and health of the plant can be secured.

Members of the School Board on finding that my attempts to introduce window gardening into the homes of the children had been attended with some success, and that several of our

teachers were anxious to help on the movement, arranged that a School Board Flower Show should take place in the following July. The result far exceeded our most sanguine expectations. More than a thousand children competed. In order to convey a fuller idea of the Flower Show, and the aim of the instruction, I will give the following extracts from a notice of the exhibition which appeared in the *Yorkshire Post* of July 30, 1878.

THE LEEDS SCHOOL BOARD SCHOLARS' FLOWER SHOW.

Among the various fêtes, galas, and exhibitions that are constantly cropping up in the town of Leeds, there has been none that has possessed for us so much charm as the Flower Show held last Saturday in the St. Peter's Board School, Leeds, a flower show which, from its novelty and the absence of all that go to make up the modern idea of such an exhibition, was, to our mind, most refreshing. The exhibitors were the boys and girls from the schools under the Leeds Board, and was an exhibition *pure et simple* of flowers grown under various and difficult circumstances, and on the whole was most creditable and encouraging.

The flower boxes, which, by the bye, in many instances were soap and powder blue boxes, in some cases neatly got up with paper and paint and ornamented, were ranged in tiers round the spacious room; the contributions from each school being kept separate, and duly labelled.

Not the least interesting feature of the exhibition was the delighted faces of the parents, who with pardonable pride pointed out 'their Jem's' or 'our Sally's' pet plant, whose bright blooms and summer-green leaves had gained a prize. And then the cleanly appearance and get-up of many a sturdy son of toil, attended by their pale-faced anxious-looking wives, and the gleam of joy that passed over their care-lined faces, was a sight once seen not easily to be forgotten when they bore down on the well-remembered geranium or fuchsia that had been the light of their pent-up home in the midst of smoke and gloom, making its murkiness radiant with its tender bright bloom, and had come to the fore a prize-winner.

It is pleasing to reflect that, amid the heavy work and severe task of educating 42,000 children in the Utilitarian three R's, the noblest sympathies of childhood's nature are not overlooked, and that the love for Nature's earthly stars and flowers is in a measure cultivated. Dwellers in the country know not fully the joy the sojourner in a town derives even from a common wild flower.

We sincerely trust this is only the first instalment of many more, and that year by year we shall have this child's exhibition more fully developed.

We congratulate Mrs. Buckton and her *confrères* on their success, and

hope they will be encouraged to continue their efforts. We take it, the good to be derived is threefold. First. It will tend to develope the best sympathies of children's nature. Second. It gives another interesting object and purpose in child life. Third. The development of blade, leaf, bud, flower, and fruit in all their wonderful and mysterious phases, must lead the most prosaic to think, and the young mind, like the opening bud, to expand; and thought is carried from the plant to Him who created it, and thus the greatest good of all is attained.

My hope is, that the rising generation will be brought up with a love and respect for plants, so that no gentleman having beautiful gardens and grounds may object to allow their being visited by those who have no gardens, and who spend their lives in the midst of the smoke and dirt of a large town.

A professional gardener awarded the prizes, which was found to be far better than any attempt on the part of the Board to discharge that office.

This year the Members of the Board have again sanctioned an exhibition, and have issued the following directions, which I have permission to insert, as they may furnish hints to school managers and others, who are desirous of encouraging the culture of plants.

Window Gardening.

The Leeds School Board have again sanctioned an Exhibition of Plants and Flowers, grown in window-boxes or pots by children attending the Leeds Board Schools, to be held about the first week in August; and the presentation of prizes, from voluntary subscriptions, to the most successful competitors from the various schools.

To avoid the labour of carrying boxes and plants a long distance, and to meet the general convenience of parents wishing to see the plants, the exhibition will be held in different localities of the borough, which will be subsequently announced.

The following regulations must be strictly followed:—

1.—The exhibition will only include window-boxes, plants in hanging pots or baskets, and plants in ordinary flower-pots. Each exhibitor will be limited to one box, which must not exceed three feet in length, *or* to not more than three pots or hanging plants.

2.—No plants will be received at the exhibition which have not been planted and solely cared for by the children themselves. This

regulation will not prevent parents or teachers assisting the children in the selection of plants, or showing them the best way of promoting their growth and health.

3.—The exhibition is strictly limited to plants and flowers *grown in the homes of the children*; and plants raised in hot houses, or purchased *after growth*, will be rigidly excluded. A professional gardener will decide on the merits of the plants, by whom any violation of this regulation will be detected, and such exhibitors will be excluded from any share in the prizes awarded.

4.—*Additional prizes* will also be given for the best box or pot of mignonette, the best box or pot of musk, best arrangement of climbing plants, best hanging pot or basket of plants; and also for the best bouquet of fresh cut wild flowers and grasses.

5.—The names of all competitors must be forwarded through the Head Teacher of each school to the Clerk to the Board not later than the month of June, setting forth at the same time the number and kind of plants intended for exhibition.

In sanctioning and arranging for this second Exhibition of Window Plants and Boxes, the School Board rely upon the hearty assistance and co-operation of the parents and guardians of the children for the carrying out of the above regulations, so as to ensure the honest and successful character of what they trust will be a general pleasure and advantage.

I feel much indebted to the editor of the 'Queen' for allowing me to use the drawings and directions for raising foliage plants from seeds which have lately appeared in an article contributed by Mr. Tegetmeier to the columns of that interesting paper. To Mr. Abbott, Demonstrator to the Leeds College of Science, I have to tender my warmest thanks for the valuable assistance he has rendered me during my study of the following books: Dr. Carpenter's 'Vegetable Physiology,' Lindley's 'School Botany,' Asa Gray's 'Lessons in Botany,' Thomé's 'Text Book of Science,' Darwin's 'Climbing Plants,' Darwin's 'Fertilisation of Orchids,' Sir John Lubbock's 'British Wild Flowers in relation to Insects,' Robinson's 'Walks and Promenades about Paris,' Hulme's 'Plants, their Natural Growth and Treatment,' Owen Jones's 'Grammar of Art,' 'Guide to the Royal Botanic Gardens and Pleasure Grounds, Kew,' by Daniel Oliver, F.R.S., F.L.S.,

Keeper of the Herbarium, &c., Professor of Botany in University College, London, 'Official Guide to the Kew Museums which contain the substances plants furnish for the use of man,' with additions by John R. Jackson, A.L.S., Curator of the Museums. Through the kind assistance of Mr. Jackson, I have been enabled to arrange the different families of plants in the same order in which they are placed in the cases in the Museums at Kew.

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TOWN AND WINDOW GARDENING.

FIRST LECTURE.

THE SEED.

I DID not expect that so many of you would succeed in your first attempts at rearing plants in our smoky town of Leeds. You will remember that at my last lecture on the Laws of Health, I told you that if you would send me your addresses I would visit your homes and examine the plants and window-boxes for which I had offered prizes. I was very much afraid that I should not be able to fulfil my promise, as some of the sixty-four addresses which I received were very imperfect. Fortunately the coachman was able to discover a great many of the streets and houses, by catching sight of the little flower-boxes which generally stood on the sills of the upper windows. I wished it had been holiday time, for then I might have found you at home and heard all you had to say. I had the pleasure, however, of seeing your mothers, who were very kind, gave me a great deal of interesting information, and explained some of your difficulties. Directly I understood your difficulties I decided I would study the nature of plants, and come and tell you all I knew about gardening. I learned more from examining the boxes in which the plants had failed, than from those in which they had succeeded. I always gave a reward where great pains had been taken. One little boy told his mother he was glad he had done his best to rear a little plant which had died after all his care, because, he said, 'You see, mother, some of

our neighbours have bought plants since they have seen mine.' Another boy, who could not afford to give one and sixpence for a window-box (the cheapest new one I could find), went to a grocer's and bought a soap-box for three halfpence, which when it was painted looked as nice as the best. The house he lived in had no window sills, so he was obliged to put his box in the yard. The cats came every night until they had killed all his plants. I hope by next spring his father will have some iron fasteners put into the wall by his bedroom window, upon which a box can stand, as I found this had been done at one of the houses I visited. This boy was much too fond of flowers to be overcome by cats. He managed to rear a beautiful Fuchsia in his bedroom, from a tiny cutting, by keeping the window so clean that every ray of sunshine could pass through the panes of glass and shine on his little favourite. You can see a picture of this little Fuchsia in the photograph I had taken of the plants shown in the Town Hall (frontispiece). I was very sorry to find that the windows in some houses could not be opened either at the top or bottom, and had no sills. Even here I found that some plants had been reared. A damp little area furnished a place where a fern and some ivy were flourishing. In another part of the town I discovered a pretty box containing the following plants, which looked very healthy :—Virginian Stock, French Marigold, Fuchsia, Musk, Nasturtium, Pansy, Marigold, though the window looked to the north. The mother told me she had always lived in the country before she came to Leeds, and had long sighed for the sight of a bit of green, but her husband had always told her that it would be impossible to rear plants where they lived. The father, however, had been persuaded by his son to buy the pretty box I saw. I learned from another mother that her husband, who could neither read nor write, was delighted with all his sons repeated to him of the information gained at my lectures, and had set to work, bought seeds, and had made the sitting-room window look exceedingly pretty. A Convolvulus was creeping up the sides of the window, by the help of a piece of string, and there were pretty plants on the window sill. His delight now, she said, was to take his boys into the

country whenever he had a holiday. I could tell you many more stories which interested me very much, but I have only time now to explain the photographs I hold in my hand before I begin my first lecture on plants.

When you went to the Town Hall last July to receive your prizes from Sir Andrew Fairbairn, I hope that you saw the stand under the orchestra, upon which about sixty-one of your window-boxes were placed, because I hear it was greatly admired. I should like to have had it photographed, but the photographer told me the effect would not be good, owing to the great mass of green. Another year you must try to have more flowers. I selected the two boxes that gained the first prize, and two plants which were reared in flower pots. One of the latter is the Fuchsia I have just mentioned. Annie's box contained the following plants:—three Geraniums, a cluster of Lobelias, Pansy, Calceolaria, a variegated-leaf plant. Kate's, a border of blue Lobelia; centre, Mrs. Pollock Geranium, four scarlet Geraniums; one yellow Calceolaria; Golden Feather, and a variegated Geranium at each corner. There being no window-sill, this box rested upon irons fastened to the wall. The large box, which has an arch, gained the first pupil-teacher prize. Wonderful to say, that box, with all its contents, only cost ninepence. I asked H—— whether he would kindly write its history, in order to show you how much can be done by taste and ingenuity.

History of a Pupil Teacher's Window Garden, 1876.

As soon as I understood the arrangement concerning Window Gardens, I went to the grocer's and got two old boxes of him, giving threepence each for them. I now took one end out of each of them, and then, by placing the boxes endways together, and joining them together with the two pieces of wood, one taken from the end of each box, I made them into one large box, using the same nails that I had taken out of the box ends. After placing about an inch of ashes and cinders at the bottom of the box for drainage, I found that I had no soil sufficiently good for a window box, so I got some decaying leaves from a heap that had been

swept from off the street causeway the previous November, some common sand from out of a street grate, and a little common soil. This, after being chopped with a spade, mixed, and sifted through a sieve, was put into the box, and has by now formed itself into very rich soil. Into this compost the annuals now contained therein were sown, consisting of Mignonette, Saponaria, Musk, Sweet Peas, Convolvulus major; the Golden Feather and Lobelia were inserted when small plants. The Nasturtium came up accidentally, and was not, therefore, in a suitable place. To obviate this, I removed it a few days ago, which has somewhat retarded its growth. The ornamentation on the box has taken from twelve to fourteen hours to do, and is purely of my own design. The grass and moss I collected from off waste ground near home; the willows were grown in our own garden, and the rough wood I picked up in the street. The expense of the box, plants, seeds, etc., has been about eightpence.

H. H. H.

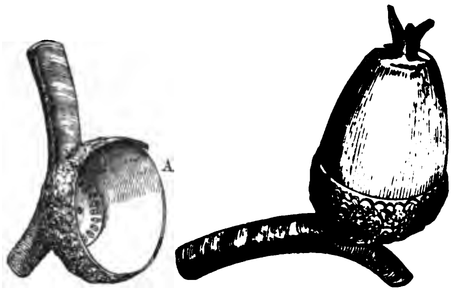
I am glad you attended my lectures on the Laws of Health, and the Structure of Man and Animals, because you will have gained a great deal of information, which will help you to understand the nature of plants, for plants are living creatures. During these lectures I shall endeavour to prove that unless plants have a variety of good food and breathe fresh air, they will grow deformed and become miserable little unhealthy creatures, die of thirst when deprived of water, and grow fat or thin according to the food they eat. Bad gases kill them, as all know who have tried to rear plants near to chemical works, or in a living room where gas is constantly burned. A living plant is covered with a skin that has thousands of holes or pores, through which the perspiration escapes, and, therefore, requires to be kept very clean and washed with soap and water. Some plants perspire seventeen times more than a human being. A Cabbage and a Sunflower lose one pint and a half of water in a day.

You remember the story of the gilded Roman boy whose skin was varnished with gold to make him look like an angel, and the next morning his mother found him dead, because he

had been poisoned by the perspiration being kept in. A young green plant would be poisoned and killed in the same way if it was covered with varnish.

All plants require rest, and many of them fall asleep as night comes on, or for three or four months during every year at a certain time. When they are awake, they work very hard, for they work both night and day.

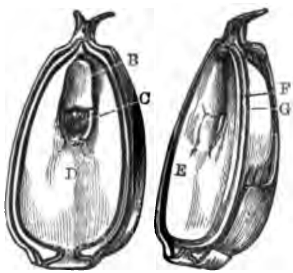
FIG. 1.



An Acorn which contains the seed.

You have heard a great deal from me about the organs of the human body. An organ is a place where something is made or done. The leaves and the stem are the principal organs that a plant has. Plants, you know, grow out of a seed. Every ripe seed contains a tiny little plant, or germ as it is called. This little plant, or germ, has a stem and leaves and is to be found lying snugly in a certain part of a seed surrounded by food, upon which it will feed, directly it begins to grow and work in the ground. No living thing can grow and work without food. The first work that the little plant does during the time it is in the seed, is to make the stem grow so tall that it can get out

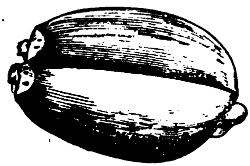
FIG. 2.



Acorn opened to show where the little germ or plant lies. B and C, stem and bud of little plant; D and E, the two seed-leaves filled with food (starch); F and G, the two thin seed skins.

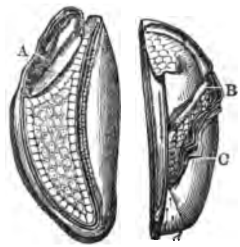
of the earth, and carry up the leaf or leaves that stand on the top of the stem, and place them where they can get fresh air and sunshine. The leaves then begin to work and make all the food that the plant requires, and send down roots into the earth, to suck up water which the stem carries up to the leaves. I have brought models of two different kinds of seeds. One is an Acorn, out of which an Oak-tree grows. Fig. 1 shows the acorn. Fig. 2 shows the seed opened, so

FIG. 3.



Grain of Corn which contains the seed.

FIG. 4.



Grain of Corn divided to show where the little germ or plant lies at A. B, the two seed-skins; C, the three skins of the dried leaf called a carpel that cover the seed.

FIG. 5.

Little germ A removed from seed (fig. 4). D, seed-leaf; E, leaf-bud; F, stem.

FIG. 6.

Grain of Corn opened to show how the centre is filled with starch cells G.

that you may see the little germ with its stem and leaves folded up into a bud.

This second model is a grain of corn (fig. 3). We will open the seed (fig. 4) and take out the little plant or germ and examine it (fig. 5). You can see the stem (F) and a tiny leaf folded up into a little bud (E) lying upon the seedling leaf (D), which is fastened at the back of the stem and bud, that looks like a shell. This curious leaf shall be

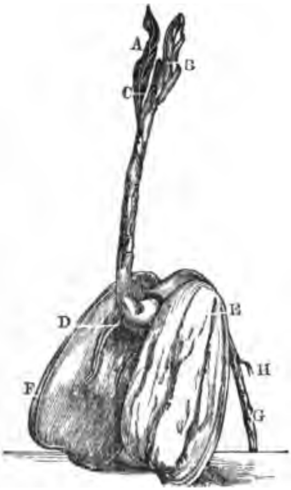
explained in another lecture. We will now open the seed in another place, to examine how the food is placed. You must notice very particularly that there are a great many little cells in the centre (fig. 6). These cells contain starch and a living substance, called by a long and difficult name, *protoplasm.* I have written the name down for you to copy, because you will often hear me speak of protoplasm during my lectures, for it is a most wonderful substance. We will now suppose that the seed is put into the earth, which must be warm and damp. The earth must not be sticky like clay, but light and easily separated, so that air and water can pass through it just like the earth I have in this flower-pot, which has some clean sand mixed with it. At the end of the lecture I intend to show you exactly how seeds should be set.

When the seeds have been in the earth a short time, the water that is in the earth will have softened the two hard skins of the seed, so that air and water can get to the little plant or germ. The oxygen that is in the air and water will mix with the living matter called protoplasm, which will then begin to work and turn the starch into sugar, provided the earth is sufficiently warm, as great cold kills the little plant. When the starch has been turned into sugar, the sugar will mix with the water, and the little plant will feed upon it. A little plant or germ in the seed is like a little baby; it cannot digest any food like starch that will not mix with water. I have some starch and water in this tumbler, which you see has not mixed at all because all the starch has fallen to the bottom of the glass. You will find that the sugar I put into this glass will dissolve and entirely disappear, because it has thoroughly mixed with the water. The stem and bud feed upon the sugar and water until the leaves have grown out of the earth into the fresh air and sunshine to work for their own living.

Suppose that the seed were to be set so deep down in the earth that the food was all eaten up before the stem and leaves could grow sufficiently tall to get out of the earth, to prepare all the food the plant requires and send down roots to suck up the water the stem carries up to the leaves,

what would happen? Why, then the plant would die, or, as people say, 'the seed would never come up.' The seed will, perhaps, be planted so that the leaves are down and the stem up; but it does not signify, for in that case the little seed is provided with the wonderful power of turning itself the right way up. Here is a model of a seedling Oak (fig. 7), which shows you how the plant places itself in the earth.

FIG. 7.



Seedling Oak. A and B, first green leaves; C, bud between the leaves; D and E, two fat seed-leaves filled with starch; F, the two thin seed-skins which cover the seed-leaves; G, tap root; H, hair root.

FIG. 8.

Grain of Corn that has sent down roots into the earth and its first green leaf and bud out of the ground. H, first green leaf; I, bud at the foot of leaf; M, L, K, roots; N, hair root; J, seed-leaf at back of stem.

The root (G) is down, and the two green leaves (A and B) appear at the top.

Now, I will show you a model of a grain of Corn, as it would look after it had been in the earth a short time (fig. 8).

You must notice that the curious little leaf fastened to the back of the stem is still there, and that only *one* leaf comes out of the top of the Corn stem. The seedling Oak is different,

you will observe, having *two* leaves appearing at the same time, with a little bud between. You must also notice the difference in the roots. The Oak has only one root, called a tap-root; the corn has three. The roots of both plants have very delicate little hair roots growing upon them, which should not be injured. If you disturb your seeds, these roots will therefore be spoilt. I found that some of you had grown impatient, and had taken up the seeds to see if they were growing. I noticed that in boxes where no seeds had come up, the earth was as hard as a brick; then I knew that the little plants had died for want of water and fresh air, and that wonderful gas, called oxygen, in fresh air, which you heard so much about in my lectures on the Laws of Health.

Things taken to the Lecture.

Sugar, Starch, Flower-pot filled with Earth, Seeds, two tumblers of Water.
MODELS.—An Acorn, Seedling Oak, a grain of Corn, and one in a germinating state.

Questions for First Lesson.

1. Give a description of the little plant or germ that is found in every ripe seed.
2. What happens to a seed when it is set in the earth that is warm, and damp, and through which air and water can easily pass?
3. Why does the little plant or germ in the seed never come up when it has been set too deep?
4. What will a seed do if it has been set so that the little plant it contains has its stem up and the leaves down in the earth?

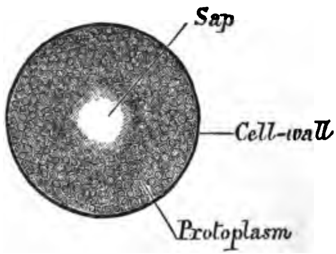
SECOND LECTURE.

THE STEM.

THE organ I am about to describe to-day is the stem or trunk of an Oak-tree. Before I begin to tell you about plants which bear seeds and flowers, such as trees, shrubs, and herbs, I should like to give you a little history of the simplest plant in which no organs can be found, called the Yeast Plant. Though it never grows to be anything more than a little bag or cell, and is so small that it cannot be seen by the naked

eye, it can do very wonderful work. It lives and grows very quickly in a variety of foods; but if you feed it on sugar and water, it not only grows very quickly, but causes two new substances to be made out of the sugar. One is called alcohol, the spirit in wine, beer, and all fermented drinks, which intoxicates people; the other substance is carbonic acid gas. You will naturally wonder what this little bag or cell contains that enables it to do such wonderful work. I have drawn you a little picture of it, which shows what it is made of.

FIG. 9.



Cell Plant.

It is the living matter protoplasm that gives the little plant the power of making spirit and carbonic acid out of sugar and water. The food which these plants feed on passes through the outer skin in which there are no holes.

I have given you this little history of a cell plant in the hope that it may enable you to understand the wonderful fact that the biggest tree and all plants are built up by cells of a similar kind to the Yeast Plant. One might fancy that each cell contained a skilful little workman. As the cells grow old the outside, which is wood, grows thicker and harder, and when the cells are quite dead their skeletons become so hard that they last for many hundred years, as you will find when I describe an Oak-tree.

If you were to examine a green leaf with a powerful magnifying glass, you could see these cells, because they are soft and alive so long as the leaf is green. No organ is so wonderful as a leaf, because it makes all the food the plant requires, and a great many substances that man and animals must have or they would die. I will mention a few of the most important substances—wood, coal, charcoal, wheat (from which we make our bread), starch and sugar. Without wood alone we should have neither houses, furniture, ships, fire, or manufactories in which all the wonderful machines are made that man has invented. Wood, charcoal, and coal

are chiefly made of a wonderful substance called carbon. The purest carbon is a diamond, which is so hard and strong that it will cut glass. I have one in my ring, which you will see looks perfectly white like glass. The carbon that is in coal, charcoal, and wood is not pure, because it is mixed with other substances which colour it.

I have told you that the framework of the smallest plant,

FIG. 10.

Oak Tree.

such as the Yeast Plant, is made of wood. I am going to show that the framework of the biggest plant, such as the Oak, is also made of wood. The Oak-tree is considered the finest of all British forest trees, and is called the 'monarch of the woods.' The wood is so hard and durable that pieces of furniture are to be found in a perfect state of preservation, made of Oak-wood, that were constructed several hundreds of years ago.

When we wish to praise a man for his honesty and courage

and endurance, we say, he has a heart of Oak. The Salcy Oak is still living and is said to be one thousand five hundred years old. The bark looks very rough, as if it was knotted and split open in some parts; it is this appearance which makes people speak of a 'gnarled Oak.' 'Gnarled' means knotty. The roots spread out for an immense distance under

FIG. 11.

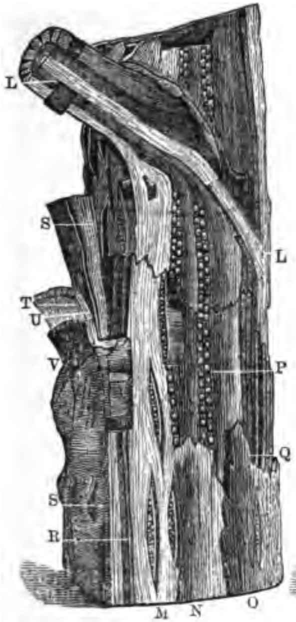
Palm Tree.

the ground, and look like creeping branches. The branches are very numerous, and the foliage very thick. The bark of all Oak-trees is made of cork; but it grows the thickest on the Oak which grows in Spain, and it is from this tree that stoppers are made which we use to put into bottles. I am not surprised that King Charles selected an Oak-tree

when he escaped from his enemies, because its branches are so thick and gnarled and numerous that they would be sure to hide him from view.

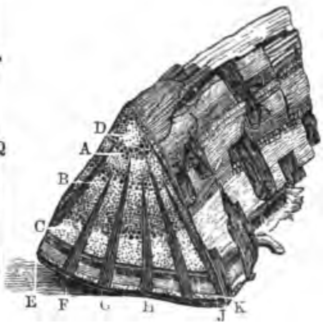
By examining the trunk of an Oak-tree you can tell how

FIG. 12.



Model of a part of an Oak trunk and branch. L, L, pith running up centre and into branch; M, N, O, three rings of wood running up the trunk; P, ducts; Q, spiral vessels; R, cambium. From the cambium, R, to the outside corky cover, V, it is called the bark; S, liber; T, U, two soft green skins; V, outside corky cover.

FIG. 13.



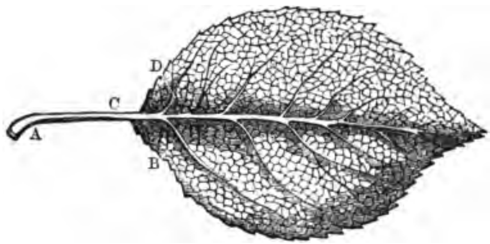
Piece of Oak trunk showing a part of the three rings of wood, A, B, C; pith, D; pith rays, E, F, G, H, I, J; bark, K.

many years it has lived; when once you understand its construction, you will know the construction of all British trees, shrubs, and herbs, for they are all made upon the same plan, except Grasses. Trees that grow in hot countries like the Palm-tree (fig. 11) are differently constructed, as you can see by comparing it with the picture of the Oak-tree. The Palm-tree has a long narrow stem without any branches

except those that grow on the top. I am very glad to say I have a beautiful model of a piece of the trunk of an Oak-tree, three years old, showing part of a branch. How can I tell that it is three years old? Because every year a fresh ring of wood is made. If we look at the bottom of this piece we shall be able to see these rings (fig. 13, A, B, C.) In the centre of the trunk there is a round white star or sun (D). It is made of pith. The lines or rays that are coming from the pith or sun are called 'pith-rays,' because they are made of pith. These rays are fastened to the bark or outside covering of the trunk, and bind the rings of wood together, as you will see in fig. 13 (E, F, G, H, I, J).

We will now examine the stem lengthways (fig. 12). You see the pith (L, L) runs up the middle of the trunk,

FIG. 14.



Skeleton of Leaf. Woody fibres spreading out to form the skeleton of the leaf at A, B, C, D, &c.

and into the branch, and the three rings of wood are carried up like three bands (M, N, O). The oldest ring is very dark, and the one made last year is very light, and called 'sap-wood' (M). Every new band or ring of wood that runs up the trunk is made of bundles of cells that fit one upon another like these glass pipes I hold in my hand. They are long, and as fine as threads, and are called woody fibre. 'Fibre' means thread. Between each band of wood come some little dots, which are called 'ducts' (P). Some of the bundles of woody fibre pass into the branches and then into the leaves, where they spread out and make the delicate frame-work or skeleton, which you see in this picture (fig. 14, A, B, C, D). These woody fibres also pass down

from the leaf through the stem into the roots, and unite every part of the tree together. The roots grow hard and firm in the ground, and prevent the wind and storms of winter from blowing the tree down or tearing it up by its roots. The curious spiral vessels (Q) which you see passing up by the pith are extremely delicate, and are therefore covered over and protected by part of the first ring of wood (O). The wood on the upper part has been removed in some parts, so that you may see them. They always lie by the pith, and pass with the pith into every branch, leaf, and flower. It is thought by some naturalists that they carry air. They are called spiral vessels, because they are twisted and look like a corkscrew.

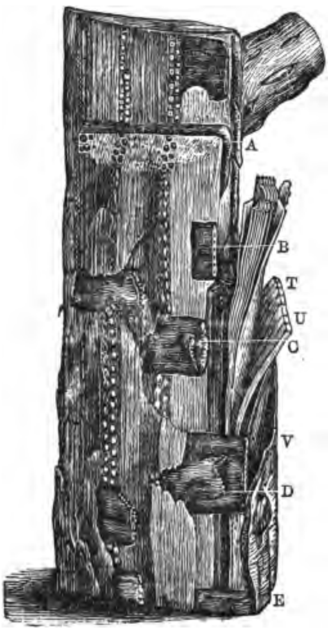
You will notice that next to the last ring of new wood there is a black line (R) which separates it from the bark (fig. 12, p. 13). This black line is the cambium, in which there is that living matter called 'protoplasm,' out of which, next spring, all the new cells and organs will be made. Directly the warm weather and the sunshine come, the sap begins to rise and the protoplasm to work. Remember we are looking at a model of a tree, in the winter, which has fallen asleep. Now we come to the bark, which lies outside and protects the protoplasm. Though we call all this part the bark, it contains a great many most valuable substances, which differ in various plants.

Next to the protoplasm there is a light substance (S) that looks like the leaves of a book. You see, I can separate these leaves. The Latin name is *liber*, which means a book. Before paper was invented the Romans used these sheets to write on. Liber is made of those long thread-like cells called woody fibre. Mats, and sails, and cordage are made out of it in some countries; our English gardeners divide it into strips, like these I hold in my hand, and use it for tying up their plants. It is this part of the Flax plant which is made into linen.

Now we come to two very important skins (T, U) which are green. They are made of soft cells, which never grow hard. It is through these that the sap returns from the leaves to feed every part of the tree that is growing.

You can see these skins and their cells in this model (fig. 12, T, U). The outside cover (V) is that skin I told you about, that is made of cork. Cork, you know, will not let any water pass through it, so you see the protoplasm and delicate green skins are well protected from cold and wet. Why has this corky covering split open in some parts?

FIG. 15.



Side of model of Oak trunk, showing how the pith-rays bind the rings of wood together at A, B, C, D, E; T, U, soft cells; V, corky bark.

FIG. 16.

Exogen Stem tied round to prevent the sap from descending to feed the lower part of the stem.

Because every new ring of wood is larger than the last one. As the bark does not grow so quickly as the wood, it becomes too tight, and here and there bursts open. Stones are sometimes found buried far in the trunk of a tree, and people who do not know that with every fresh ring that is made year by year, the stone is pressed further into the centre, wonder how it got there. On the other hand, if a stone was put into the

bark, it would soon be pushed out and fall to the ground, because the bark grows outwardly, and keeps peeling off. I told you that the sap which the roots suck up is carried by the stem up into the leaves. The sap only rises in the spring and summer, when the buds begin to grow and the leaves are on the trees. The cells of wood are then soft, and the sap passes up through the new ring of wood called sap-wood. When the leaves have made the sap into food, it comes down to feed the plant by a different road, through the soft green cells in the bark. If you wish to prove this fact, you have only to tie a cord round the trunk of a tree, made like the Oak stem, in the summer-time, and you will find the sap cannot pass through the place where the tree has been tied, but stops there, and makes that part bulge out as it does in fig 16. After a time, the bottom part of the stem would wither, because no food could reach it.

Questions for Second Lesson.

1. If you could examine a leaf, or any part of a tree or a plant with a very powerful microscope, how would you find it was made?
2. Of what substance is the skeleton or framework of a tree or any plant made?
3. How can you find out the age of a tree?
4. Describe all you can remember about the trunk or stem of an oak tree, and through what part the sap is carried from the roots up into the leaves, and how the sap is carried down again into the roots.

THIRD LECTURE.

THE BUD.

A PLANT that bears flowers, fruit, and seeds must either be a tree, a shrub, or a herb. The trunk and branches of a tree stand above the ground for a great many years, like the Oak tree, and the tree is called a 'perennial,' because 'perennial' is a Latin word that means lasting a long time. A shrub lives above ground for several years and is also called a perennial. A shrub never has one thick trunk, but a great many small stems and branches like a Holly-bush, from

which you get red berries at Christmas-time. There are plants called herbs, which look very like small shrubs, and stand perhaps two or three feet above the ground. These plants die altogether when winter comes. If you were to dig up the earth in which they stood, you would find that every bit of their roots had disappeared. These plants are called 'annuals,' because they only live part of the year, like Mignonette. 'Annual' comes from a Latin word which means a year.

There are some herbs that lose all their branches and leaves in the winter, and disappear from the face of the earth, so that you might fancy they were quite dead, like an annual. This is not really the case, because a piece of stem and the roots remain under ground all the winter, and the plant grows up again in the spring,—such as Mint and Parsley. Carrots, Turnips, and Cabbages are herbs that grow above ground for two summers; then they die, roots and all. All trees and shrubs except evergreens, such as a Holly-bush, lose their leaves in the winter. Don't you think that it is very wonderful that fresh leaves come again so quickly in the spring? I have often taken a walk in April and found the hedges looking quite dark, not a bit of green was to be seen. A week later I have gone down the same lane, and found, to my surprise, that the hedges had become so green that I hardly knew them again in their beautiful new dress.

As it is now the middle of winter (December), we will examine this branch that has been taken out of a hedge. There is nothing to be seen except some little joints and places that look like a wound or a scar. You must notice these scars, because they are the places where the leaves grew last summer. When they fell they left a hole that has been carefully healed and covered up. Though this piece of wood looks quite dead and lifeless, there are little buds lying inside the stem, just above each scar and joint.

What is a bud? It is like the little plant or germ I have told you so much about, that lies in every ripe seed, which has a stem and some leaves folded up into a little bud. The germ in the seed was surrounded by food, and so is the bud that lies in the stem. The leaves of last summer not only

made all the food that they required, but filled the stem with food for the little bud to live upon until its leaves grew large enough to prepare their own food, and send down roots to suck up sap. Each leaf, you see, has its own little roots or servants. The stem serves as a means of conveyance between the roots and the leaves. The sap is carried up by one road, and brought down by another. The bundle of woody fibre that passes from the leaf through the stem down to the roots not only joins all these parts together, but is composed of little pipes or long cells through which the sap is carried into the green soft cells that cover the skeleton of the leaf as soft flesh covers our bones.

FIG. 17.

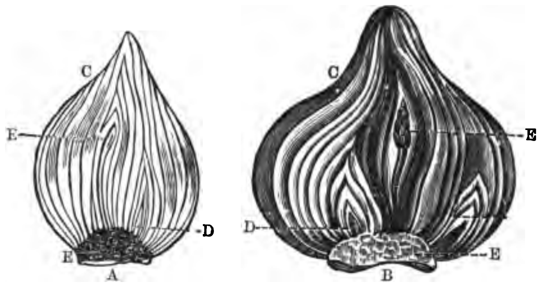
Buds of the Horse-chestnut. A, winter bud; B, bud opening in spring; C, flower.

Here is a very small branch of a Horse-chestnut tree (fig. 17). The buds on this tree grow outside and can easily be seen. This bud (A) is so sticky, I can scarcely bear to touch it. My fingers, you see, are covered with varnish. Buds that lie outside the stem are exposed to all the cold of winter. Day and night they have to bear frost and snow, wind and rain. You will not be surprised that they can bear all this, when you see how tenderly they are protected. We will carefully examine the inside of this bud. First, it is covered with varnish. Varnish is a substance like india-rubber, that will not let any water or damp pass through it. What did I tell you in my last lectures was the warmest covering an animal could have, because it kept in all the heat of the body?

Down. And here, between each leaf, is some soft white down to guard and protect the little bud inside. Buds on a Horse-chestnut tree become an immense size when they burst open in the spring, as you will see in the picture, by comparing the bud (A) covered with varnish and the bud (B) as it looks when it has just opened. The flower of a Horse-chestnut is something like in shape to the flower of the Hyacinth. With a glass it can be seen even in the smallest bud in the autumn. Until the leaves have quite opened so that they can work and make fresh food, we know that the bud is feeding upon the supply of food that was stored up in the stem last autumn.

Trees, even in the winter, are very interesting to look at.

FIG. 18.



Tulip and Hyacinth bulb divided. A, tulip; B, hyacinth; C, C, leaves or scales; D, D, buds beginning to grow; E, E, buds that have advanced in growth.

I often think I admire them more without their leaves, because then you can see the shape of their branches, which look so delicate against the sky. Now that I have described how buds are provided with food in the stem, you will understand how it is that trees become so quickly covered with their new set of leaves, but I do not think you understand how it is that the ground becomes as suddenly covered with Snowdrops and Crocuses in the spring. If you take a walk into the woods at this winter-time, where you gathered those flowers last year, you will find nothing but dead leaves lying thick over the earth. Though you can discover nothing but leaves, buds, called bulbs, lie buried in the ground like these I hold in my hand, which are Crocuses and Snowdrops. This

bulb is a Hyacinth. It is a large bulb, so that we can examine it when it is divided.

All these scales (C, C) are leaves. At the bottom of them there are little buds (D and E). Each of the leaves that protects the little bud or plant is full of food. We know this, because if you put the Hyacinth into a glass filled with nothing but water, it will grow and send down roots if kept in a dark place. Here is a bulb in a glass, so that you can see how long the roots have grown. You must take care and put them where they have no sunshine, or the leaves grow first, eat up the food, and then no roots can grow to suck up water, and the plant will die. A dark cellar is a good place for them. After a month or two they should be brought into a living room and be kept by the window where they can get plenty of sunlight. Unless flowering plants have sunshine, the flowers will have very little colour and very little scent. The perfume of flowers is said to make the air not only sweeter but purer.

This is a month (December) for planting bulbs, but November is better. They will come up in March or April. I shall be very glad to give prizes for the best bulbous plants that you can raise in boxes or pots, or anything else you like. I am going to plant some bulbs in this small soap box that cost twopence, that you may see how to plant them properly. You must take care to make holes at the bottom, as I have done, so that the water can run out, and not stand in the earth. If the earth is too wet the roots will rot, and the earth will become sour and have a disagreeable smell. Sour food is as bad for plants as it is for babies. The holes enable fresh air to get into the earth and keep it sweet. We must put a piece of old crockery over each hole and take care that it is not quite flat, or it would shut up the hole and prevent the water from running out, and air from coming in. We must next put some cinders, called drainage, through which the water will easily pass or drain, and which must fill a third of the box. Small pieces of crockery would do as well, but cinders are better for the plants. Now comes the earth at the top. Before I mix this earth with sand, you must notice that it is not at all sticky, because it

crumbles and easily divides after I have squeezed it in my hand. Any kind of sand will do that is clean and dry. This I have is powdered scouring-stone. The reason I put sand is to prevent the earth from sticking together, so that the air and water can pass through it. You will wish to know how much earth and how much sand to use. Have an equal quantity of each.

I think the best place for you to buy your bulbs is the market. They are not very expensive, as you will see from the list of prices I have added to the paper on which your questions are printed.

I will now put in the bulbs. Crocuses shall be planted round the edge of the box, and the Hyacinths and Tulips down the centre. They must not be put deeper than two inches in the earth. You see I just cover these over with a handful of earth.

Questions for Third Lesson.

1. What is the difference between a tree and a herb?
   What do gardeners mean when they say that a plant is an annual or a perennial?
2. How are the leaves joined to a branch, and how are branches and roots joined to the stem or trunk?
3. How do new leaves come on the trees and hedges in the spring?
4. How do Crocuses, Hyacinths, Snowdrops, etc., grow every spring in the woods?

Hyacinth bulbs	. . . . . .	2½d. each.
Tulip do.	. . . . . .	9d. per doz.
Crocus do.	. . . . . .	20 for 3d.
Snowdrop do.	. . . . . .	20 for 6d.

FOURTH LECTURE.

THE LEAF.

By my lecture to-day I hope to make you understand how the heat is made in plants, and how they get all the carbon they require. Though a plant feels quite cold when you touch it, it has heat because it is a living thing, and only

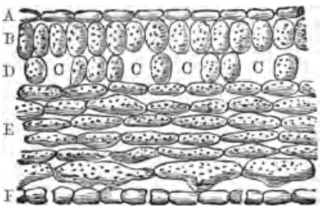
becomes quite cold when it is dead. The heat in men and animals is nearly all made by oxygen gas and carbon joining chemically together. I will prove by a little experiment that when these two substances join together they make a great deal of heat, and carbonic acid gas. I have two bottles before me. This one is filled with oxygen gas; and the other, which is open at the top, contains the air we are breathing, and which fills this room. There is a great deal of carbon in charcoal. This piece of charcoal or burnt wood which I hold in my hand is hot and red, and I will put it into this bottle of oxygen gas. Now, you see the tiny red spark of heat has burst into a brilliant flame, and the bottle has become very hot; because the oxygen gas in the bottle has joined with the carbon that was in the piece of charcoal or burnt wood. You will find that the bottle is no longer filled with oxygen gas, but with that poisonous gas, called carbonic acid gas, which comes out of our mouths every instant. Carbonic acid gas will put out a light instantly. Men and animals cannot live in this air, carbonic acid gas.

You must remember that carbonic acid gas is made of oxygen gas and carbon. Men and animals grow very hot when they work very hard, because they breathe very quickly, and take in a good deal of air, which contains oxygen gas. The oxygen gas joins with the carbon in their bodies, and makes heat and the carbonic acid gas which is constantly coming out of their mouths. Plants also become hot when they grow and work. Growing is very hard work. This can be proved by the heat that seeds make when they are growing. If a great many seeds are put together in a dark room which is warm and damp, they will soon begin to grow, and the heat they make after a short time will raise a thermometer to 110 degrees. When Wheat, Barley, or Oats are put together in this way, they change into a substance called malt.

You will understand what an immense quantity of carbon plants require, when I tell you that a tall Oak-tree contains several tons of carbon. (A ton weighs 2,240 lbs.) Humboldt, the celebrated traveller and naturalist, tells us that he found forests in South America so large and thick, that monkeys

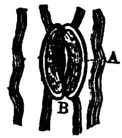
could run on the tops of the trees in a straight line for a hundred miles, with no gaps between them. Millions of tons of carbon must have been used in making all the wood, etc., in these trees. Every substance made by a plant, when it has become dry, is nearly half made of carbon. I have told you that carbon is a very hard substance. How, then, can a plant feed upon it? A plant or tree is built up of little cells, in which there are no holes; their food, therefore, must either be a liquid or a gas. What did I just now tell you carbonic acid gas was made of? Carbon and oxygen. Plants breathe, as human beings do; they take in one kind of air and send out another. Fortunately they take in carbonic acid gas, which poisons men and animals, and send out oxygen gas.

FIG. 19.



Thin strip cut across the leaf of the Lily. A, cells that make the upper skin of leaf. B, second row of cells placed upright; D, third row of cells; C, spaces for air between the cells; E, fourth row of cells; F, cells that make the under skin of leaf.

FIG. 20.



Pore to let out the moisture, called a stoma. B, pore; A, hole in pore through which the perspiration or water runs out.

Plants take in carbonic acid gas because they want the carbon which it contains, and which they are able to separate from it in a wonderful manner. This work is accomplished in the green cells of a leaf.

I told you that if you could examine a leaf with a powerful magnifying glass, you would find that it is made of different shaped cells, lying one upon another, as they do in this paper model I have made of a leaf (fig. 19). The top row of cells (B) placed under the upper side of the leaf (A) are long cells standing upright, like a row of bricks. Then come round cells (D) put here and there, with large spaces (C) between them to hold air. The skin that covers the top (A) and under sides (F) of the leaf is made of flat cells.

The skin that covers the under side has been removed in this model, to show you some of the holes or pores (fig. 20) through which the leaf breathes. They look like little sausages (B) joined together, so that a dark hole (A) is left in the centre. The dark holes in the centre are the pores, through which the air passes in and comes out. When the carbonic acid gas has entered and filled the air-spaces, it passes into the little green cells. The green substance which gives the colour to the cells is that living matter, protoplasm, which has the power of separating the carbon from the oxygen when the sun shines on the leaf. The carbon is kept fast in the cells, and the oxygen is sent out to purify the air. The protoplasm in the leaf cannot do this unless it has sunshine; therefore leaves only take in carbonic acid gas during the daytime. At night they take in oxygen gas, and send out carbonic acid gas. Some of the carbon that is collected during the day is turned into starch. At night the oxygen gas that plants take in turns the starch into sugar, which is carried down by the stem through the green cells in the bark, to feed every living part of the plant. You see they make their food by day, and eat it during the night. I told you that they work both night and day. Plants must have fresh air, which contains oxygen, at night, to prepare their food, because it is the oxygen gas that turns the starch into sugar, or they would be starved, and grow thin and unhealthy. Plants, like human beings, will be healthy in a sitting-room or bedroom that is well ventilated. A healthy plant sends out very little carbonic acid gas. Unhealthy ones send out a good deal.

Plants cannot live long where gas is kept burning, because the gas-light uses all the oxygen gas, and the bad air that is left poisons them in a very short time. At one of the houses I visited I found a little Musk plant in a dying state. It was thought very strange that it did not grow well, as it was placed high up on a window-ledge in the living-room, where a great deal of gas was burned. The air at the top of a room lighted by gas soon becomes terribly bad and impure. A plumber once told me that he wished ladies and gentlemen would mount up a ladder at night to examine the top of a chandelier, because he was sure one such visit would make them find out some way of

driving out the bad air, and bringing in a plentiful supply of that which is fresh and pure.

It is said that the oxygen given out by plants is a very powerful kind called *ozone*, which is good for delicate people. There is very little ozone to be found in the air of a smoky town. This is one reason why I am anxious for you to keep plants. The doctors send their patients into the country, where the mountains are high, as the air on mountain tops contains a great deal of ozone.

FIG. 21.

Thirsty plant:—Primula.

Leaves not only take in gases through the pores of their skin, but a great deal of perspiration comes out through their pores. The greatest number of pores are generally found in the under side. In one single leaf of an Apple-tree there are said to be one hundred thousand pores. On a hot summer's day a Sunflower loses one pint and a half of perspiration, and a Cabbage even more.

Plants that live in countries like England, where rain is constantly falling, have a great many more pores than plants that live in hot or dry countries. They perspire a great deal, and so get rid of the water that the roots suck up out of the wet earth. In dry countries a great deal of dew falls at night, and the leaves are often covered with fine little hairs, such as you see on the leaves of this Geranium or Pelargonium, a plant which originally came from the Cape of Good Hope. These little hairs are fine little pipes, through which

the dew is carried into the cells in the leaf. When the dew begins to fall, these hairs are said to stand upright, to receive all the dew or rain they can get, and when they have received a sufficient quantity the hairs fall down again. When a plant is very thirsty, it will take in water through its skin, as human beings will do when they are dying of thirst; but the roots generally suck up all the water that the plant requires. You can easily find out when a plant in a flower-pot is thirsty, by knocking the sides of the pot. A hollow sound comes when the earth is dry, and a dull sound when it is wet. The leaves also become soft, and hang as they do in this picture of a thirsty Primula.

FIG. 22.

Cineraria:—Gouty plant.

If plants have too much water and too little sunshine to make them perspire, they grow dropsical and gouty, and the leaves fall as if they were thirsty. Here is a picture of a gouty plant.

Though the leaves fall as if they were thirsty, you would soon discover that this is not the case, for on striking the sides of the flower-pot, a very dull sound is made, which shows that it has had too much water, instead of too little, and has had no sun to make it perspire. When you water a plant, you want the water to sink down to the roots, so that they may suck it up and carry it to the leaves. Go on watering, therefore, till you see some water runs out through the holes at the bottom. Water your plants in the summer before the sun rises. If you pour water on to a burning leaf, the water becomes hot and scalds the leaf, instead of passing through the pores. Copy nature: when a shower falls the sky is always cloudy.

After all I have said about a leaf and the way it is made, I hope you will understand how important it is that leaves should be kept as clean as the skin of our bodies. Directly they look the least dirty, which they will soon do if kept in a smoky town or living room, get some very clean water, and a little soap, not too much or it will fill up the pores; spread the leaf on your hand and quickly wash off the dirt with your other hand or a piece of sponge. The soap must be rinsed off with clean water and wiped dry, just as you would a child's face. Now that I understand how leaves are made and the all-important work they have to do, I feel quite sorry when I look at a dirty plant in a window, and long to tell the owners all I have told you. Remember that the under side of a leaf must also be washed, as there are so many pores on that side, and the stems of a plant when they are green. I will now wash a few of these leaves to show you how they should be done. If the leaves are very fine and small, like this on this plant called French Lavender, you should wash them by squirting water over them, or if they are in a flower-pot you can turn them upside-down and hold the earth in with your hand, and rinse them backwards and forwards in the water. Of course you would not do this if the plant had flowers or seeds. This little squirt costs three-pence. By putting a finger in the front of the hole at a little distance, the water spreads out like rain, or as it does from a watering-pot.

Questions for Fourth Lesson.

1. What are the names of the two substances that join together chemically and make the heat of men, animals, and plants?
2. As plants cannot feed on anything but air and substances that will dissolve in water, like sugar, how do they get all the carbon they want, which is a very hard, solid substance?
3. Why do plants require oxygen gas, particularly at night?
4. Describe how a leaf is made?
5. Why must leaves be kept clean, and washed with soap and water? How would you keep very small leaves clean that are too tiny to wash in this way?
6. How can you tell when a plant that has leaves is thirsty, and by what means can you find out whether the earth in a flower-pot is dry down by the roots?

FIFTH LECTURE.

THE ROOTS.

YOU learnt from my lectures on the Laws of Health that men and animals must eat three kinds of food to be strong and healthy: called body-warmers, or carbonaceous foods; flesh-formers, or nitrogenous foods; and mineral foods. Plants must also eat these three kinds of food to be healthy. So far, I have only mentioned how plants get all the carbon to make their carbonaceous foods, such as starch and sugar. The carbon in starch and sugar is not pure because it is mixed with two gases, oxygen gas and hydrogen gas. Wood is also made of these three things, oxygen, hydrogen, and carbon. If you were to give the cleverest chemist in the world oxygen, hydrogen, and carbon, he could not make a piece of wood, or a piece of sugar, though he knows exactly the quantity it would take to make them. The plant, you see, has been taught to do what men cannot do with all their knowledge. The brain, the muscles, and all the organs that men and animals possess can only be made by foods that contain nitrogen. As these organs are constantly wearing out, it is necessary that a great deal of this food should be eaten daily by which they may be repaired. Perhaps you think men might buy some of this gas and mix it with their food, or that the nitrogen that is in the air will mix with their blood, as oxygen gas does. No, a man could no more do this than he could make a piece of sugar. Plants make all the nitrogenous foods that men and animals must eat. All grain, such as Wheat, Oats, Barley, also Grass, which cattle eat, contains a great deal of nitrogen. How do plants get all the nitrogen that they want? Not out of the air, because nitrogen gas will not mix or dissolve in water; and plants, you know, cannot eat anything that will not mix with water. They get it out of a substance that contains nitrogen, called ammonia, which will mix with water. It is made of nitrogen and hydrogen. I have some ammonia in this bottle. It smells so strong that I can scarcely bear it. I dare say you all know it, because it is given to people to smell who are

fainting. Ammonia rises from dung that falls from horses. If the dung is left on the ground of the stable in which they are kept, ammonia rises and makes them blind. All dying matter that has formed a part of men, animals, or vegetables, such as manure, dead leaves, and branches, sends out ammonia, which either rises into the air or mixes with the earth in which it lies. When rain comes it washes the ammonia down into the earth. The little roots suck up this water, which has salts of ammonia dissolved, and the stem then carries it up to the cells in the leaves, and there it is soon separated into nitrogen and hydrogen. The nitrogen is kept in the cells and the hydrogen is liberated.

You will understand why plants require a great deal of nitrogen, when I tell you that the living matter called protoplasm contains a great deal of it. Wheat, Barley, and Oats require a great deal of nitrogen to make the gluten, which is the part that feeds our organs. Animal manure contains more nitrogen than vegetable manure.

The Chinese are a very clever and industrious people, and therefore waste nothing. Their country is so full of people that they would be starved if they did not have heavy crops of corn. Instead of wasting all the organic matter that comes out of their houses, and which we allow to be carried away by drains to run into our rivers and pollute them, and from which air rises which causes all kinds of fevers, this valuable matter is poured over the corn fields in China, and immense crops of corn are annually raised which contain a great deal of nitrogen. In Holland the grass is finer than in any other country, because the cattle there have grazed in the same fields for hundreds of years. Farmers in England waste a great deal of nitrogen from ignorance. They heap up manure in their farmyards, and the air becomes filled with ammonia, which is very injurious to men and animals. If they would only throw some sulphuric acid and water over their dung-heaps, all the ammonia would be kept fast inside them, because sulphuric acid is very fond of ammonia, and mixes with it, and so prevents it from escaping into the air.

Good gardeners, like good cooks, waste nothing. Every bit of dead animal matter should be collected together and be

covered over with earth, and then the fresh air, or the oxygen that is in the air, would soon change its nature, remove all unpleasant smell, and turn it into a valuable manure.

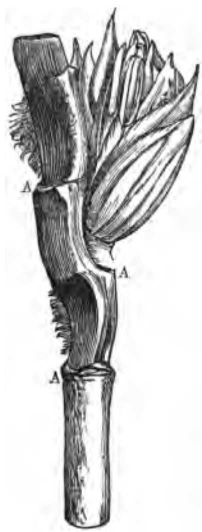
In Germany, the banks of the beautiful river Rhine are covered with vineyards. Not long since, a poor old man, a vine grower, who depended entirely for his support on the grapes which his vines produced, became in despair on seeing that his vines were going to decay, because he knew he could not afford to buy the manure which he saw they needed. Manure is very expensive in these hilly countries, because it has to be brought up the hills in carts. As he was wandering one day amongst his vines, he noticed that on one side of them the grass grew thicker about those spots on which the branches of the vine had fallen that had been cut off or pruned in the spring. He thought the matter over and said: 'There must be some reason for this. No doubt the young green branches have nourished the ground and enriched it. Why should they not nourish my poor vines?' He cut a deep hole round their roots into which he put the branches after he had cut them up in pieces. Being green and cut up small, they would soon entirely decay. In one year the barren vines became quite beautiful. Of course on seeing this he continued the plan every year, and they grew splendidly and continued green the whole summer, even in the greatest heat. His neighbours wondered very much how his vineyard was so rich and his crop of grapes so large, as they knew he was too poor a man to buy manure. When you are puzzling and wondering how you should feed your plants, go and look how trees and flowers flourish which have no human gardener to provide for their wants. The best earth, suitable for all the plants that grow in England, is to be found in a hedge where a great many plants have grown for many years. Their dead remains will have served to make food for their relations who have followed them year after year.

I have still the third kind of food to mention, which men, animals, and plants must have, or their frames will be weak. Plants grow deformed, like men, if they do not eat food which gives them the strength to stand upright. It is mineral food. The mineral food which plants require is of several kinds. I

can only mention a few of them—flint, iron, potass, etc. No food is more important to plants, as good farmers well know. When they see a crop of wheat lying on the ground, as if it were tired, they know that the earth it has been growing in has not enough flint, or silica, as it is called. Grasses have very little wood in their stems. They are made firm and strong by flint. You see this model of an ear of Corn, and part of its stem (fig. 23). The stem is hollow, and therefore would be very weak, but for the great quantity of flint that is to be found in each of the joints and leaves.

Phosphorus and lime are the two substances that make the hard part of our bones. Wheat contains a great deal of them, and for that reason it is so important that children should eat a great deal of bread. Potass is the mineral found in potatoes, fruit, and all green vegetables, and prevents people from having the scurvy. When once minerals have been sucked up by the roots (salts soluble in water), and sent into the cells in the leaves, the minerals cannot get out again. The walls of the cells become crusted with the minerals, just as the inside of a tea-kettle is crusted with the minerals in the water. For this reason the green leaves of Lettuce and all salads are very good, as we eat them uncooked, so that none of the contents escape.

FIG. 23.



Ear of Corn.
A, A, A, joints in stem.

Roots are now the organs I must tell you something more about. The first work the root has to do is to fasten the stem firmly in the earth, so that it may not be blown away by the wind. I have often thought, on looking at a tree, some of whose roots have been left bare, that they appear like a large hand grasping hold of the earth. Though roots look like branches, they are differently made. Branches have joints, but roots have none, as you will see by comparing the stem of Wheat (fig.

23) with the roots of the seedling Oak (page 8) and the germinating grain of corn (page 8). There is a little bud lying above each of these joints in the stem. These buds come out and form leaves and branches. Roots have no leaves, buds, nor pith in which the food is kept, and on which the bud feeds. You see, pith is not needed, as there are no buds. The roots, in some respects, are made like the stem; they have a fresh ring of wood every year, which is protected by bark. They are soft when young, but if they live more than a year, they grow hard. The soft cells at the end of the root, which have to push their way through the earth, are protected by a covering that looks like the top of a thimble, so that the tender growing part may not be injured. The large roots do not suck up sap, as was formerly supposed. The sap is sucked up by those fine little hairs which you can see in the two models I have shown you (figs. 7 and 8, page 8). These are sent down by the young roots in the spring. They are so fine that they can squeeze themselves into any little soft place or hole. If they come to a stone they either creep over it or round it; and if they come to a wall they squeeze themselves between the little holes that separate the stones. As the roots continue to grow thicker each year, like the stem, they burst the wall at last to pieces. This is the way a mill-stone in a quarry is split into pieces: holes are made in the stone; then pieces of wood are put into them; the wood is then made very wet; the wood swells so much that it bursts the stone open. It is stated that roots have destroyed more buildings than armies, earthquakes, fire, storms, or rains. This is very wonderful, when you think that all this is done by roots that have begun their work no thicker than a thread. When roots are in a soft or sandy soil they can travel an immense distance in search of water. A tree standing on the side of a road has been known to send its roots deep down where the earth was wet and soft, across the road, until it reached a pool of water on the other side. Roots have been also known to wander along a bare rock to get to water that was at a distance of twenty feet.

It almost seems as if roots had a kind of instinct, for they not only go long distances in search of water, but they seem to

choose out of the ground the kind of food that suits them best. For instance, if a grain of Wheat and a Pea are growing in the same earth, the Wheat will take all the mineral I have just told you about, called flint, and the Pea takes all the lime.

Now that you can understand something about the stem, leaves, and roots, which are the principal organs of a plant, you will easily understand, I think, how to rear your own plants from cuttings, as well as from seeds. It is particularly necessary that window-gardeners should know how to do this, for they have only a small space in which to rear their plants, which must not be large. Cuttings set in April will bear flowers in summer, and still be small in size.

What is a cutting? It is a piece of a stem which must have at least three joints, and as many more as you like. You remember that a little bud is lying above each joint in the stem, surrounded by its food, that will be sufficient until it has leaves and roots to work for itself. Here are the joints in this model (page 32, fig. 23). This little cutting, which I am going to plant to-day, has not only three joints, but it has two leaves at the top. When the sun shines upon it, each leaf in the buds will begin to grow, and send down roots into the earth, to suck up the water and minerals the plant requires. Should the leaves perspire, the sap will soon be all used up before the roots have had time to grow. The plant or little cuttings would then die for want of water. What are we to do then, because the leaves must have sunshine, or they will be unable to work? Fortunately we know an important fact, that neither plants nor human beings perspire much when the air about them is damp. How can we keep the air damp? By placing a tumbler over the cutting. You will find that the glass becomes quite damp from the

FIG. 24.

Geranium Cutting.

moisture that rises out of the warm earth. This moisture must be wiped off at times, or it would poison the plant. In a week or two you will find the little plant has taken root, or 'struck,' as gardeners say; then you can remove the tumbler.

A friend of mine told me she had failed to rear cuttings time after time. I found, on asking her a few questions, that she had put them in a sunny place, and had never covered them over with glass to prevent the leaves from perspiring. I should like you to see me take a cutting from a plant, and plant it. My knife is sharp, and I shall take off these three joints, leaving two leaves at the top (fig. 24). I must see that my flower-pot is not only quite clean outside and in, but very dry. I put a piece of crockery over the hole, cinders over that, and then earth and sand, which is mixed together. The earth was got from a hedge near Harrogate. You can see some old decayed roots in it. I will now shake the pot, so that the earth can sink down about a quarter of an inch from the top, or when I water the plant the water would run over the sides. I will now make a hole in the centre, to receive my cutting. A pencil or any piece of wood will do for this purpose. My cutting is altogether about three inches high. I shall put an inch of the stem into the hole, and press the earth down. Now I shall water it, until I see the water runs out through the hole in the bottom. In a week I shall give some more water. I will now place the tumbler over the cutting, and this piece of wood to lift the tumbler up, so that fresh air can get underneath the glass. Of course cuttings must be taken off perennial plants. It would be no use to take a cutting off an annual; these only live one summer.

Questions for Fifth Lesson.

1. Why cannot plants live without nitrogen gas? How do they get this gas?
2. Why do gardeners mix manure, such as dung, decayed leaves, branches, etc., with the earth they use for plants, particularly to feed annual plants, such as Corn, China Asters, etc.?
3. Where would you get fresh earth for your window-boxes and flower-pots?

4. How did the old vine-grower make his Vines grow, and bear a great quantity of grapes?
5. Tell me some of the reasons why plants have roots.
6. What is a cutting? Why must the leaves of a cutting be kept in damp air, have light by day, and fresh air at night? Tell me how you would plant a cutting?

SIXTH LECTURE.

SUNSHINE.

I AM now going to tell you some of the wonderful effects that light has upon plants. During the daytime we have two kinds of light: one is called 'direct sunshine,' and the other 'diffused daylight.' The sun sends all its light down upon the earth in straight lines called rays. If these rays while passing through the air meet with nothing on their journey until they strike upon a plant, that plant is said to have received direct sunshine; but should the rays strike against any object or be obliged to pass through clouds of rain or smoke before they reach the plant, that plant is said to have received only 'diffused daylight.' 'Diffused daylight' is much weaker than direct sunshine, because the rays in it while passing through the cloud are absorbed or sucked up as water is sucked up by a sponge. Direct sunshine has the power of making the sap in the leaves thick. This thick sap is said to contain a good deal of protoplasm. Flower-buds and flowers require a great deal of this living matter.

It is said that flower-buds, when put into a room where no direct rays of sunshine enter, have changed from flower-buds into leaf-buds because the sap grows thin. The sap which feeds leaf-buds is thin.

Gardeners have several plans by which they make plants produce flower-buds and very few leaf-buds. One of these plans is to bend the branches down over a wooden framework, because the sap cannot circulate so quickly in a bent stem, and therefore grows thick.

When you go to a flower show you must notice plants that are trained in this way over wooden frames. You will see they have very few leaves and an immense number of flowers. I do not admire these plants so much as when they grow naturally and have their proper quantity of leaves and flowers. Flowers soon drop off where they have not had enough direct sunshine. The sun's rays are the strongest in the middle of the day when the sun is just over our heads, for they (the rays) come down very straight.

In countries near the middle of the earth, called the Tropics, the sun is always just over the earth during the middle of the day. People who happen to be out during that time are often killed by a sunstroke. Plants are all the better for sunstrokes; indeed, they would die if they could not get sunshine, because it is only this kind of light that gives the green living matter in the leaf the power of separating the carbonic acid gas into carbon and oxygen. Without carbon you know plants would have no wood or food, have weak frames, and be unable to stand upright. This is one of the reasons why plants that have always lived out of doors make more wood, and have stronger frames, than those brought up in greenhouses or indoors. Warm damp air without sunshine makes the sap thin, and plants grow tall and soft, like overgrown, ill-fed children who have been kept in hot nurseries.

If you wish to prove this fact, put a plant into a warm damp cellar; you will find that it grows tall, has a great many leaves, and bears very few flowers. Without direct sunshine plants would have very little colour, flavour, or scent. The upper side of a leaf is, you see, a darker green than the under one, because a great deal more sun rests on the upper side. It is a curious fact that if the dark side is turned down, the leaf soon turns itself the right way again; but if it cannot manage to do so, it withers and soon dies.

I must now tell you facts which prove that sunshine gives plants their bright colours and their different flavour or peculiar taste. Celery and Seakale are vegetables that naturally have very green leaves and stems, and a most disagreeable taste, so disagreeable that it is impossible to eat them. Gardeners found out that when these plants were kept in the

dark, the stems and leaves not only grew white like these I hold in my hand, but lost all their disagreeable taste and were very good to eat. They are made white by being completely buried in the earth, so that no sun can get to them.

We get all our spices, such as pepper, mustard, nutmeg, and ginger, from tropical countries. Those countries, I just now told you, lie where the sun's rays strike straight upon the plants. The plants that produce these spices will grow in hot-houses in England, but no amount of heat has the same effect as the strong rays of direct sunshine which rest upon a plant in hot countries.

When you go to London you must visit the Botanical Gardens in Regent's Park, and also Kew Gardens, about which I shall say more during my lectures. I was very much interested in seeing the fine collection of plants that have been brought from all parts of the world in the Botanical Gardens, Regent's Park. The finest scents can only be got out of flowers that grow in hot countries. The Roses that grow in England have a very sweet perfume, but their scent is nothing in comparison with otto of Roses that is got from Roses that grow in the tropics.

Plants can bear very great cold if the air is very dry and sunny; damp frosty air such as we have during autumn and spring in England kills young and tender plants. I have a collection of dried flowers here which I brought last autumn from a mountain in Switzerland, more than 5,000 feet above the level of the sea, called Mürren, so steep that no carriages or carts can go up; people either walk, or are carried up on chairs by men, or ride on horseback. Though Mürren is more than 5,000 feet high, it is surrounded by much higher mountains that are covered with perpetual snow and ice. The snow falls very early—it was beginning to come down in September when we were there—and lies on the ground for several months. The snow falls so deep that the poor villagers are almost unable to leave their houses. You would hardly think that flowers which die during the winter in England will grow in that cold place. Some of the dried flowers that I have in this box are to be found growing in Yorkshire; the only difference is that they are smaller and shorter than

ours, but their colours are more brilliant. I should like to visit Mürren in spring, because I am told that the ground becomes covered with flowers almost in a single night, as if by magic. People wonder at this who do not know that buds, called bulbs, from which these flowers spring, lie buried deep in the earth, and are kept snug and warm by the snow.

The snow falls very early in the autumn while the earth is warm. This heat in the earth cannot get through the snow, because snow is a non-conductor: that means, it is a substance through which heat cannot pass. When the sun shines in the

FIG. 25.

Mürren is 5,348 feet above the level of the sea. The white summit is the Eiger, 12,000 feet high. This house stands about 3,000 feet above the valley that lies beneath it.

spring, its rays strike down straight upon those high mountains, melt the snow, enter the earth, and wake the little buds up to life. The strong light and great heat make them grow very rapidly.

The valleys between these high mountains are so narrow and deep that the sun's rays do not enter them directly, but strike first against the mountains and get bent, so that the poor peasants who live in the valleys get a great deal of diffused daylight. This weak light makes people, like plants,

grow weak and unhealthy. The people suffer from a disease in their throats, and a great many of them have weak minds. Doctors send them to hospitals built high up on the mountains, where they can get direct sunshine. Here their throats soon grow better and their minds stronger. Even consumptive people are sent to these places to be cured, because the air, though cold, is very dry. Dry air contains a great deal of oxygen, damp air very little.

After all I have said about sunshine I hope you will give yourselves and your plants every ray you can get. Open your windows and keep them very clean so that the sun's rays may enter. The air in a large smoky town is much the best early in the morning before the mills send out their clouds of smoke, through which the sun's straight rays try in vain to pass.

Before I finish my lecture I will strike a cutting of a Fuchsia, as it is not planted exactly like a Geranium cutting, which I showed you how to strike last week. The Geranium cutting had four joints and two leaves. With some kinds of plants it is only necessary to pinch not *cut* off a piece of a branch or twig that has one joint, and it will take root when put into the earth. I have a Fuchsia in this pot which looks as if it were dead, but you can see that two or three buds on the side of the stem have just begun to open their leaves; I will now pinch off this budding part of the stem with my finger and thumb and plant it in this pot of earth. Cuttings must always be taken from new wood. They cannot therefore be struck except in the spring, summer, and autumn, when the sap is rising. The best time to take cuttings is in August, for then they can be planted out of doors when the earth is warm, and they can grow strong in the fresh air. Here is a Geranium which was a small cutting planted last August. A gardener at Harrogate had hundreds of them struck at the same time with this, which he kept during the winter in his greenhouse. As you have no greenhouse, nor a room to keep plants in during the winter, I recommend you to strike your cuttings in the spring, either in March, April, or May. They will grow into nice little plants by July.

Plants that lose their leaves every autumn are called

'deciduous,' from a Latin word which means 'to fall.' These plants can be put into a dark cellar, or anywhere, when they have lost all their leaves. They only require to be brought into a room where there is light in the spring, when their buds are beginning to grow. But plants called evergreens, which have leaves both summer and winter, would become very unhealthy if you were to put them where they could get no light. A Geranium, for instance, dies if put into a dark place. Every plant must rest at some part of the year. Even evergreens, that appear as if their leaves never fell off, do lose them gradually, and fresh ones gradually come in their places. Though they work very little in the winter, they must have air and light to keep the sap moving, but very little water.

Questions for Sixth Lesson.

1. Tell me some of the reasons why flowering plants can live in the earth during the winter on the top of mountains 7,000 feet high, upon which thick snow lies for several months in the year, that would die at the top of mountains in England or Scotland, though these mountains are only about 4,000 feet above the level of the sea.
2. Tell me the name of the light that helps a plant to make living matter called protoplasm, food, flower-buds, colour, flavour, scent, and the sap thick.
3. Tell me the name of the light that helps a plant to make the sap thin, and to form wood and leaf-buds.
4. Why is it necessary that the windows of a room in which human beings and plants live should be kept very clean?

SEVENTH LECTURE.

ROOTS, STEMS, AND FLOWERS.

You will remember that in my first lecture I told you that every ripe seed contained a perfect little plant, which consisted of a stem and leaves. This little plant with its stem and leaves grows out of the seed and out of the earth. Let us

see what happens then. The little bud that lies between the leaves at the top of the stem opens out into another stem and leaves, and so on until a big tree is built up by thousands of little plants standing one upon another, fastened together by joints. The little buds that lie above each joint in the stem are ready to open and grow into branches. Sometimes they never do open, as we see happens in the trunks of trees upon which are no branches, because the top branches prevent the air and sunshine from getting to the bottom part of the trunk or stem. A plant has only two organs—a stem and leaves.

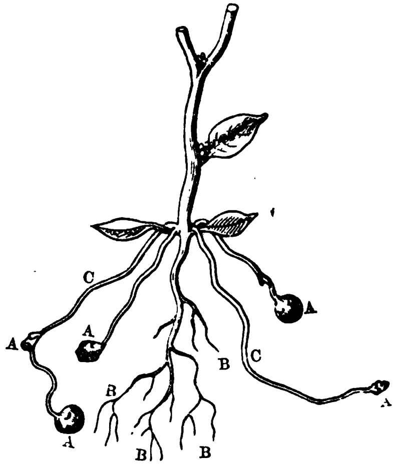
FIG. 26.

Radish.
E, crown.

FIG. 27.

Carrot.
F, crown.

FIG. 28.



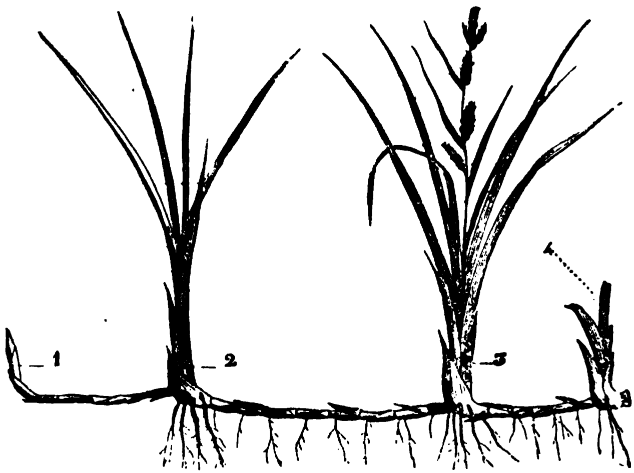
Potato.
A, young potatoes; B, roots; C, stems.

Men, and a great many animals, have at least forty organs. I am going to show you that plants have the power of changing these two organs into most curious shapes to suit the work they have to do. Roots, which are a part of the stem, are sometimes so strangely altered that it is almost impossible to believe they are roots. Turnips, Radishes, and Carrots are roots. They live two years, and then they die. These plants are called 'biennials,' which means 'lasting two years,' the time they live. The first year they have no flowers, only a

bunch of green leaves. These leaves work very hard and fill this big root with food for the plant to feed on the following summer. The roots during the summer grow very thin, and die directly the flowers wither. We take up the roots the first autumn when they are fat, and eat all the food they have taken such trouble to prepare for the next year.

How are we to know that Turnips and Carrots are roots? Because they have no joints and no buds, and you can see some little hair rootlets coming out from their sides as well as at the bottom of them.

FIG. 29.



Couch-grass.

People who do not know how a root is made, think that a Potato is a root. A Potato is a piece of a branch which contains several joints and buds, and becomes so swollen out with food that it grows round and hangs from the stems like a ball. If you examine a Potato, you will see little holes here and there. These holes are the places where the joints and buds lie. People call them 'eyes.' When gardeners want a crop of Potatoes, they plant small Potatoes, not seeds. If the Potato is very large they cut it into pieces, so that each piece shall contain two or three buds, called 'eyes.'

If a Potato plant is put to grow in a dark place where its leaves cannot get direct sunshine to make food, the plant lives upon the food stored up in its branches, which then grow quite thin and elegant. You learn from the history of the Potato that stems and branches sometimes grow underground.

FIG. 30.

Aaron's Beard (Strawberry Saxifrage).

There are some very troublesome plants called weeds, whose stems grow underground. Couch-grass is one of them (fig. 29). Ignorant gardeners think it is a root, and try and dig it up by its roots; but digging only chops the stem into small pieces, and makes it grow all the faster. The little buds in each piece of stem grow into fresh plants, which send up branches and leaves above ground, and also others that run along underground, destroying all the plants they find on their way, by twining round them so fast that they are choked or

strangled. The only remedy is to take up every bit of the stem.

Some plants creep in the same way as Couch-grass above ground. The Strawberry plant grows in this way. Here and there the stem touches the ground where a bud lies, and roots are sent down which form a fresh plant. It is winter-time, so that I cannot show you a Strawberry, but I have a little plant to show you that grows exactly in the same way, called Aaron's Beard. You can see that one of the creeping stems has grown over the sides of the flower-pot and is hanging down. You will often find Aaron's Beard growing in baskets suspended from a ceiling and the stems hanging over its

FIG. 31.

Banyan Tree (*Ficus indica*).

sides. At the end of these long stems there are little plants whose roots strike into the earth directly they touch it. The large Banyan trees that live in the East Indies send down similar stems or branches, and when the roots touch the ground they serve as props which may cover acres of ground. It is said that seven thousand people could stand and find shelter under one of these trees now living. This you can understand when you hear that it has three hundred and fifty principal trunks, and smaller stems amounting altogether to three thousand, which are still sending out new branches and hanging roots. I can show you a picture of a Banyan tree.

Some plants have roots which grow up into the air instead of down into the ground. The common Ivy that covers our walls has these aërial roots, as they are properly called.

Some of the roots fasten the Ivy into the ground, and others climb to a great height and fasten the plant to a wall or a tree. Rocks and trunks of very high trees are often completely covered by Ivy.

Plants, you see, can not only move along the earth, but can climb up precipices and visit places where men cannot go.

Leaf-buds, we know, change into branches. It is more difficult to realise that a flower-bud is only a folded-up branch whose stems and leaves are changed into a beautiful coloured flower. We know this is a fact, because flower-buds have been seen to change into leaf-buds. A leaf-bud, until it has opened and spread out its leaves so that they can work and prepare fresh food, feeds on the food stored up in the pith, lying in the centre of the branch, that was made by the green leaves of last summer. A flower-bud not only feeds on the food stored up in the branch while it is growing, but also when it has opened out and become a flower. The beautiful coloured leaves of a flower called petals cannot work.

FIG. 32.

Agava.

All the food a flower eats is prepared by the green leaves that grow on the same stem, and very hard these poor servants have to work, because flowers take an immense quantity of food. I will give you the following history of a plant called the Agava, or American Aloe, which will show you that flowers are entirely fed by the food which is prepared by green leaves. I have no doubt you have often seen Agavas in green-houses. They are natives of tropical countries, and though they grow well in the South of Europe, they can only grow to their full size in their native countries. Their leaves are extremely thick, or fleshy, as they are called, and very large. Sometimes they grow to be eight feet long, or even more. Each leaf ends in a strong sharp point. The point is about three-quarters of an inch in length. When these leaves are soaked in water, the sharp point is drawn out and brings with it a bundle of woody fibres that make the skeleton of

the leaves. These fibres are used as coarse threads, and the sharp point as a needle, and they are called 'Adam's needle-and-thread.' In Mexico, its native country, this plant takes from eight to eighteen years before it bears a flower. In England it is only said to bear a flower once in a hundred years. For a hundred years the leaves toil hard to store up a sufficient quantity of food to feed the flowers, fruit, and seeds while they are growing. Directly the flowers have faded, and the fruit and seeds are ripe, the food is all used up that was in the leaves, and the poor plant dies, tired out.

FIG. 33.

Unpruned Geranium.

FIG. 34.

Geranium pruned : top bud taken off.

Flowers grow very quickly in hot countries because the flower-buds get so much direct sunshine. The top buds are always the strongest, because they get the most sun. These strong buds take more than their share of the food that lies in the stem, so that the poor little buds that lie below are starved and have not the strength to come out. Here is a Geranium whose top buds have grown in this way. What a tall lank plant it looks—not a branch to be seen low down!

Now I will show you a Geranium that was planted at the

same time and grew in the same greenhouse, but whose top buds were taken off. How different it looks—quite bushy and not nearly so tall!

A gardener can make his plants grow just the shape he wishes by taking off certain buds. For instance, if he finds the plant is growing too tall, he nips off the top leaf-bud, and then the buds that are low down on the stem will have strength to grow and come out, because they will get the food that is stored up in the stem. If he prefers to have a few handsome flowers instead of a great many poor ones, he knows where the flower-buds lie, and nips a few of them off.

Never let flowers remain on the stem when they begin to fade, for directly they fade the seeds begin to form. Seeds take a great deal of food, even more than flowers. You cannot have seeds and good flowers. When plants are kept in small pots their roots cannot suck up much sap, and then the sap in the plant becomes thick. Thick sap, I told you, has a good deal of protoplasm, and it is this thick sap upon which flower-buds feed. Directly you put a plant into a large pot the leaves begin to grow very quickly, and very few flowers appear. The roots suck up water and the sap grows thin.

I will now turn out this Geranium, that you may see how the roots are twisted round and round, and how none of them stick to the sides of the pot. I told you that flower-pots must be quite clean and dry. This Geranium has been planted in a very clean pot. If the least bit of dirt is left in the pot, the young tender roots will stick to the sides and be torn and injured when the plant is removed. Most plants can be transplanted at any part of the year from flower-pots, but it is much more difficult to transplant one that is growing in the earth, because the new little root-fibres travel a long distance in search of water. Geraniums will not bear to be taken out of a pot and put into the earth. The only way is to sink the plant and pot into the earth.

I will now show you how to prune a Geranium and a Fuchsia—that is, take off the buds to make it a nice shape.

Questions for Seventh Lesson.

1. How do gardeners manage to make the buds which grow low down on a stem become branches?
2. If a plant was growing too tall, and had a leaf-bud at the top of its stem, how would you stop its growth?
3. Why is it quite easy to remove a plant from one pot to another, if the flower-pots are quite dry and clean?
4. Why should flowers be cut off directly they begin to fade?
5. How do you know that the troublesome weed called Couch-grass is an underground stem and not a root?
6. Is a Potato a root or a stem? Tell me all you can remember about it.

EIGHTH LECTURE.

ON CLIMBING AND SUCCULENT PLANTS.

THERE are a great number of plants which belong to different families that cannot stand upright alone because their stems contain very little hard wood. The only way by which they can raise themselves up where they can get plenty of air and sunshine to ripen their fruit is to climb to the top of trees and hedges, the sides of walls, or any support they are near.

FIG. 35.

Stem of Hop, twining to the right.

I will show you that some plants climb much more cleverly than others. The Hop plant, for instance, climbs a pole by simply twisting its stem round it. The first two or three joints in the stem of a seedling Hop will stand up straight and firm in the earth, but the top bud or shoot (A) is soft and bends round to the right as if looking for something, and continues to stretch

itself out by sweeping round in circles until it finds a stick round which it twines. The top of the stem always remains free, as you can see in fig. 35 (B), because it is only this new shoot that has the power of climbing. The stem round the stick becomes stiff and strong. A twining plant climbs best in warm still weather, in a wood where it is sheltered from the wind. The most beautiful twining plants are found in the large forests of South America, where the heat is so great and the summer lasts so long that a plant like the Hop or

FIG. 36.

Convolvulus or Greater Bindweed (*Calystegia sepium*).

FIG. 37.

Stem of *Convolvulus arvensis* (field Convolvulus), twining to the left.

Honeysuckle has time enough to mount to the top of the highest trees and get plenty of light and air before the winter sets in. Our summers in England are so short that these twining plants have no time to grow sufficiently tall to ascend a tree, except the Honeysuckle, which Dr. Darwin tells us he has seen twining up a young Beech. A strong healthy Hop plant can climb a pole at least twelve feet high. The Hop is a delicate plant, and requires warmth and rich food. Its Latin name is *Humulus Lupulus*. *Humus* means rich earth. The

Hop gardens in Kent are very beautiful in September, when the Hop flowers are ready to pick.

No twining plant to my mind looks more lovely than the Convolvulus, commonly called 'old man's night-cap,' when it has mounted up to the top of a hedge or tree, and spread out its handsome leaves and white bell-shaped flowers, where they can get plenty of light and air. This picture (fig. 36) shows you the flower and the stem, which you see is curiously twisted, like a strong rope (A). The stem becomes twisted in this way in order to give it strength to pass over uneven places in the branches. This Bindweed is to be found in most country gardens, and is said to flourish in smoky towns. I hope when you next see one of these plants that you will observe how it climbs and passes from branch to branch. It could not travel in this way if the young top shoot had not the power of sweeping round in circles to seek for a support. All plants that wander from branch to branch sweep round in the same way. Plants that belong to the Bindweed family (*Convolvulaceæ*) twine to the left (fig. 37), round a stick, an opposite direction to the Hop family (*Urticaceæ*), which turn round to the right (fig. 34). You must take care to choose sticks that are not too thick, or your climbing plants will not be able to get up them. A string is often a thick enough support. You must also clearly understand that a plant which is unhealthy can no more climb than a child, who is weak and delicate, can get up a tree. Happily for us who live in England, there are a great many plants which are not only able to ascend a pole like the Hop, but can climb up dark ugly walls, looking either to the north where scarcely any sun comes, or to the east, and cling so fast that they do not care how windy or cold the weather may be. Some of these plants can even creep up a piece of wood as smooth as glass.

Men climb by means of their hands and feet; the plants I have just mentioned climb by means of tendrils. I had now better tell you what a tendril is, and give you an account of some of the wonderful work it can do. A tendril must either be an altered stem or leaf, because we know that plants have only these two organs. All young tendrils look like fine thin stems, either straight or crooked (fig. 38). When

a tendril has fastened itself to a support, it gradually becomes so strong that one tendril alone has been known to bear a weight of two pounds. When a tendril comes to perfection, it can turn to every point of the compass, go out in search of a support by sweeping round in circles, and clasp hold of the smallest twig or projection by twisting round it two or three times. A tendril has been seen to untwist and straighten itself several times, as if it had not taken hold firmly enough, or was not satisfied with its position. I tried this summer to unclasp a delicate little Sweet-pea tendril, that had twisted itself several times round a thin twig, and was surprised to find how fast it clung.

A tendril is very sensitive, feels when it is touched, and turns to the object that has rubbed against it; just the end or tip appears to dislike the light, and gets into the dark by entering the tiny little crevices to be found in wood, bark of trees, or walls. A small cushion sometimes forms on this sensitive tip, which becomes filled with a sticky substance that comes out, and glues the tendril fast. Creeping plants with this kind of tendril can ascend trees covered by moss or bark, and even climb up wood as smooth as glass, because the sticky substance or cement glues them fast. When a tendril has fastened itself firmly to anything, it grows shorter, and draws up the stem below, on which there may be flowers or fruit, by curling itself up, first one way and then another. If it curled up all in one direction, the end of the tendril which is fastened to a support would be twisted off and become loose; when a tendril fails to clasp anything, it turns aside and dies, to make way for the tendril beneath to sweep round, and endeavour to do better. Tendrils are also elastic, so that when the wind blows the plant the tendril stretches, but does not break, or it would let the branch fall that it has drawn up.

The stems of twining plants, such as the Hop or Convolvulus, we know, are not changed into tendrils, because they do not feel when rubbed, and cannot turn to any side they like, but merely twine round a stem in a certain direction. The flowers and fruit of twining plants which grow on the north side of a pole cannot get much sun. Don't you think that

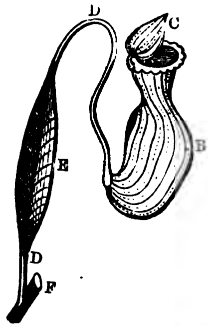
the flowers and fruit on a plant which climbs with tendrils have a much better chance of getting ripe than those on a twining plant, because the tendril plant can choose the sunny side of any support? I should think that a twining plant, with its long twisting stem, would require more food than one with tendrils.

I told you that a tendril must be either an altered stem or leaf. A leaf-stalk or stem sometimes becomes a tendril, and

FIG. 38.

Model of Pea. A, A, branches and leaves changed into tendrils.

FIG. 39.



Pitcher Plant (*Nepenthes*). D, midrib; E, one end of leaf.

the tips of the leaves hooked tendrils, so that they can catch hold of anything near to keep the plant still, while the leaf-stalk under it is bending round a twig or branch. The Clematis or 'Traveller's Joy,' that covers our hedges in May and June with white clusters of flowers (*Clematis Vitalba*), climbs by leaf-stalk tendrils; and also the Nasturtium (*Tropæolum majus*), which bears a yellow flower and green fruit. The fruit

of this Nasturtium is often gathered when half-ripe to make into a pickle. *Clematis montana* is said to be a good climber for a smoky town. In some plants both branches and leaves are changed into tendrils. You can see these tendrils in this model of the Pea (fig. 38); they look like thin twisted stems,

FIG. 40.

Venus' Fly-trap. A, sensitive spikes; B, leaf closing.

and come out where a branch should be at A, A. The stem of the Pea can also twine, like the Hop.

I will show you a picture of a plant called the Pitcher plant (fig. 39). It has this name because it is given the wonderful power of changing one end of a leaf into a pitcher (B) to hold water, with a perfect little lid (C), which closes when

the pitcher is full. The middle part of the leaf, called the *midrib* (D), is changed into a tendril that curls round a support, and hangs the pitcher in a good position to catch the rain. The rest of the leaf (E), you see, remains in its natural state, and looks like a small leaf.

Then there are plants which can catch flies, called 'Fly-traps' (fig. 40). The little spikes (A) which stand on the leaves are very sensitive, like a tendril; directly a fly touches them they bend and make the two sides of the leaf come together (B), and the poor little fly is caught. The more it struggles to get free, the faster it is held, until at last it dies. There is another Fly-trap, called the Sundew (*Drosera*). All round the edge of the leaf there is a row of fine hairs that stand up straight; at the top of each hair there is a tiny bright red ball, which, seen through a glass, looks like a precious stone called a ruby. Flies and other small insects seem to admire these balls, for they often visit the leaves of the Sundew, and then, poor things, they are caught, because a sticky substance comes out and holds them, and the hairs bend down and keep them fast. A juice also comes out and dissolves the flies, and then the leaf eats them! The Pitcher plants (*Nepenthes*) also get filled with insects that fall in and cannot get out, because the hairs point down, and prevent them from climbing up. I hope you will some day go to London, and then you must visit Kew Gardens, where you will be able to see the wonderful plants I describe to you at these lessons; because plants live and grow there that have been brought from every part of the world. I should like you to look at some climbing plants called Bignonias, which are natives of Brazil, in South America. They belong to the Trumpet-flower family or *Bignoniaceæ*, which is very nearly connected with the Foxglove or Snapdragon family (*Scrophulariaceæ*), whose flowers, you know, look so handsome in our hedges in the summer. I will give you the name of a Bignonia which I believe is to be seen at Kew, called *Bignonia Tweedieana*. It can twine like the Hop-plant, and then take hold of the stick, by first one tendril and then another, clasp it round by a leaf-stalk tendril, and lastly, to make itself quite secure, it sends out little roots from

the bottom of its leaves, which partly curve round the stick. You see this plant has learnt every method of climbing. *Bignonia capreolata* is also to be found there, and is a wonderful climber.

I told you that there were some brave climbers which could creep up smooth walls upon which scarcely any sun shone, and did not mind either smoke or wind. Now, this is the kind of creeper we want in Leeds and all dirty towns, to cover the walls of a dark area, and climb up to the top of a gloomy house. The plant I know that can do all this is a perennial called the Virginian Creeper, which does not die down in the winter, like the Hop, because the stem and branches contain a great deal of wood. Though the flowers of the Virginian Creeper are very small, its leaves are something like those of the Vine (to which family it belongs), only they are more divided.

FIG. 41.

Vine. A, tendril.

In the autumn these leaves become a bright orange, and look very handsome. A great many London houses are covered by Virginian Creepers. I have often peeped down into the London areas to see how they were planted. Sometimes I found that a tree which had nearly covered the whole house front stood in a wooden tub filled with earth. In other areas the tree grew out of a hole in the earth made by taking up a flagstone. Boxes are often put in the verandahs, from which the plant is trained either up the wall, or over the balcony. I hope you will try to ornament your cottage walls with Virginian Creepers.

I will now describe how this plant climbs. Its tendrils are four or five inches long, and, like those of the Vine, are altered flower-stalks. Directly a tendril sweeps round and touches the wall, all its branches turn towards it, spread themselves out, and place their hooks against the wall, as if they were trying to feel what the wall is like; and then they occasionally lift themselves up and come down again, as if not quite satisfied with the place they have chosen. In about two days the hooked tips swell, become a bright red, and a cushion forms, filled with a cement which comes out and fastens the tendril to the wall. When they have become quite secure, they begin to grow short, by curling round in

FIG. 42.

Virginian Creeper. A, cushions filled with cement at the end of two tendrils.

different ways, and so tug up the stem and leaves below the stem and tendrils, and grow strong and woody.

You shall have directions about planting a Virginian Creeper at the last lecture, when I am going to give some directions about plants suitable for a town (page 136).

Ferns, like flowering plants, can climb. I have a picture here of one that twines like the Hop.

I am now going to tell you about plants that are called succulent plants, because they are very juicy. They generally grow in very hot countries, where rain only falls once or twice a year. They are therefore obliged to store up a good deal of

water in their stems and leaves when they can get it. We have plants in England that are succulent, because gardeners make them grow very quickly, and they are eaten when they are very young, such as Seakale, Asparagus, and Vegetable Marrow. If they are allowed to grow slowly, the woody fibre grows tough and stringy.

Vegetable Marrow is the most juicy succulent herb that

FIG. 43.

Stonecrop (*Sedum acre*).

grows out of doors in England. In hot countries there are an immense number of succulent plants. The Water Melon is so juicy or succulent, that it almost melts in your mouth. It often grows to a large size in greenhouses in England, but in Senegal a Melon has been known to weigh sixty pounds. The Egyptians almost live upon them.

The leaves and stems of plants that grow in very hot countries are not only very thick, but their skins contain no

pores, so that all the juice which is in the stems is kept in, and they can bear to live on bare rocks where not a moss or even a blade of grass can grow. The Sedum, or Stonecrop, is a plant of this kind; it belongs to the house-leek family. It grows in Britain, and is able to bear great heat and dryness. This little plant is a creeper, and does very nicely to cover the front of window-boxes.

There are a great many curious plants which live in the tropics, called Cactuses, which have neither leaves nor

FIG. 44.

Prickly Pear Cactus. A, branches; B, stem; C, flower.

branches. The Prickly Pear Cactus is something like a Potato which grows above ground, covered by a thick green rind. The prickly tufts that stand all over it (A) are only stunted branches, which never spread out and bear leaves. Beautiful flowers come out of these curious balls just where these tufts grow (C). There is one called the giant Cereus, which grows by the Gilla River to the height of sixty feet. The most beautiful Cactus is the Night-blowing Cereus, called *night-blowing* because its blossoms only begin to open about seven o'clock in the evening, and are full-blown by

three or four o'clock in the morning. No more lovely flower is to be found, and its scent is delicious.

Though plants like these have no pores, their green skins suck in moisture or dew. Fortunately a much greater quantity of dew falls in hot countries, than in wet ones like England. The rays of the sun are so strong that they draw up the water that is stored up during the rainy season deep down in the earth, and when the cool night air comes, the water that is in the air becomes cool and falls down and rests on the plant in the form of dew. All the food stored up in these swollen stems to nourish the flowers, seeds, &c., is made by their green skins which can work like green leaves.

In islands, or by the sea, the air is very moist at night. It is in these countries that most beautiful plants live, called aërial plants, because they feed on nothing but what they find in the air. Their roots never touch the ground, only fix the plant to a dry rock and the trunks and branches of trees. Some of the roots hang down, but do not touch the ground. No doubt a great deal of moisture enters through the soft green skin of these roots, as it does through every part of a green stem and leaf. These plants are called Orchids. They grow in tropical countries, also in China and Japan. When they begin to flower the Japanese place them on pieces of wood and then let them hang suspended from the ceiling. They will live in this way and continue to bear most lovely flowers without any water for several months. I have a small Orchid of this kind to show you. It was reared at Mr. Backhouse's famous Orchid house at York. You must notice what curious thick stems it has. It is called *Dendrobium nobile.*

The Japanese prize their Orchids more than the most costly ornaments. A great many gentlemen in England have Orchid houses, and often pay more than a hundred pounds for a single plant. England is a difficult country to rear them in, because it is cold and damp. Orchids that live in warm moist countries are the most beautiful, because their flowers and leaves are very large. The flowers have a most exquisite fragrance, and generally very curious shapes, resembling different objects. Some look like grinning monkeys, others like opera-dancers, and others like insects. It must be a

beautiful and wonderful sight to walk through a forest and see them hanging to branches of trees and covering stones and rocks. Orchids are to be found in every part of the world from the arctic region to the torrid zone, but of course they are of different kinds, suited to the climate they have to live in. Many Orchids grow in Europe and Great Britain in damp meadows and woods. Some of the British ones are the Bee Orchid, Fly Orchid, Man, Lizard, and Lady's Slipper Orchid, &c. The common British ones have two oval tubers and a number of succulent fibres. The stem and roots are fastened to only one of these tubers, which die when the plant has done flowering. The young tuber is like a bulb, remains in the earth over the winter, and grows up in the spring. In this way Orchids travel along underground step by step, the old one dying and the young one advancing. It is calculated that there are about two thousand different kinds of Orchids. Vanilla is procured from Orchids.

Questions for Eighth Lesson.

1. How do the Hop and Bindweed climb?
2. Name the organs that are changed into tendrils, and describe how the Virginian Creeper, or any other climbing plant you know, climbs up a wall.
3. Describe the Pitcher plant.
4. Describe a plant called a Fly-trap. When a fly is caught, what does the plant do with it?
5. Why do English succulent plants, such as Cabbages, Rhubarb, Celery, grow stringy and tough unless they are eaten very young? How do plants, such as Orchids, get their food, that live upon bare rocks and never touch the ground?

NINTH LECTURE.

ON EXOGENS, ENDOGENS, AND GRAFTING.

THERE are a great many plants that bear flowers, and a great many that do not bear flowers. Plants are for this reason divided into two classes. Those that bear flowers belong to the

first class, and those that do not bear flowers belong to the second class. It has been found necessary that the first class, that bear flowers, should again be divided into two smaller classes, because flowering plants that grow in hot countries are very differently made from those which grow in temperate climates, such as Great Britain. I have been very anxious to explain clearly to you how the trunk and seed of an Oak-tree are made, because all our British forest trees, shrubs, and herbs are made upon the same plan. I must also tell you that all plants that have their trunk and seeds made like the trunk and seeds of an Oak-tree have a long name, formed from two Greek words 'Dicotyledon,' which means having two leaves, because all the seeds belonging to these plants contain a little germ or plant that has two large seedling leaves (page 5, fig. 2). These leaves are filled with food, and are so large that they completely fill up the two skins of the seed. If the seed is put into warm damp earth, the moisture softens the two seed-skins so that the oxygen gas and warm air can get inside and wake up the little plant or germ. The bud at the top of the stem then begins to grow, and while it is growing it feeds upon the starchy food in the two large white leaves until it can get out of the earth and spread out its two green leaves. These white leaves do not become green, because they have no food to make, but remain in the seed-skins and die away.[1]

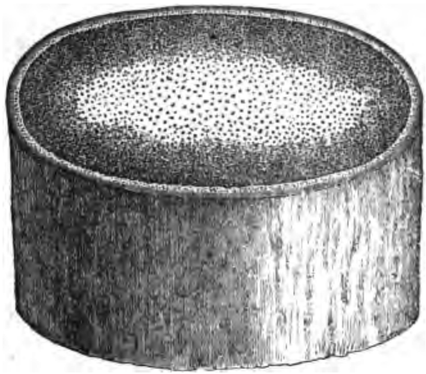
Plants which are made like the Oak are also called by another Greek word, 'Exogens,' which means growing outwardly. You remember that a fresh ring of wood grew outwardly every year. Let us refresh our memory by looking at the model of the Oak stem (page 13). The white pith comes first in the centre, then a ring of wood. The next year another ring of wood grows on the outside of it, and so on to the end of the tree's life. I hope you will now understand what is meant when people say that a plant is an Exogen or a Dicotyledon. Grasses, such as Corn, and plants like the Palm-tree, that live in hot countries, are called by another Greek name, 'Monocotyledon,' which means having one leaf,

[1] Except *Welwitschia mirabilis* (page 159).

because the little plant or germ in the seed has only one leaf, which is folded up into a little bud in the seed.

Let us examine the model of the grain of Corn (page 6, fig. 5). You would never imagine that this curious little thing that is fastened to the stem of the germ is the one leaf. I told you I would explain what it was in another lecture, as I thought you would then be better able to understand what I said. The food upon which the little germ feeds is not stored up in this leaf, but surrounds it and fills up the whole seed. Plants made like the Palm-tree have another difficult name, called 'Endogens,' which means internal growth. The centre

FIG. 45.



Palm stem.

of the stem is filled with pith, the bundles of new wood made by the leaves pass down through the pith, here and there, as you see in this picture of a section of a Palm stem, not in circles or rings as in the Oak. These stems grow taller but not thicker.

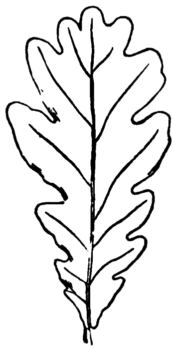
It is very necessary that gardeners and botanists should be able to find out whether a plant is an Exogen or an Endogen. This you could do at any time of the year by examining any part of a branch or stem with a small magnifying glass. Seeds and leaves are not always to be procured. The frame or skeleton of the leaf of an Exogen is very different from that of an Endogen. Here is the picture of the

skeleton of an Oak leaf. You see the woody fibres are spread out into branches called veins. The skeleton of an Endogen has no branches. The woody fibres run from one end of the leaf to the other in straight lines, as they do in the leaves of the Palm-tree and the Agava I told you about, whose long woody fibres were used for threads to sew with.

Plants are again divided into families, and then into members of families, so that gardeners and botanists may be able to find out the whole pedigree of any plant. In grafting, this information is very necessary.

I will now try to teach you how to graft, that is, to fasten

FIG. 46.



Oak Leaf.

FIG. 47.

Leaf of Lily of the Valley.

a cutting on to a stem that is growing in the ground, so that the two stems will grow together and the sap be able to pass up from the roots into the leaves of the cutting. The great advantage of knowing how to graft is that a delicate plant which cannot grow in the earth will grow and flourish on the stem of a strong healthy plant. For instance, a double yellow Rose will not grow in many places alone, but if it is grafted on to the healthy stem of a wild Rose, the yellow Rose will flourish. The same with a delicate Vine: if it is grafted on to a strong and coarse Grape, it will grow and thrive.

It would be useless to graft in the winter, for then the sap

does not rise, as there are no leaves, and the roots are still. We must wait till the spring comes. Directly the buds begin to grow, then will be the time to graft. We must take care that the two stems are of the same size and class and family. It would not do to try and make a Palm tree grow upon an Oak stem.

I told you that all the new organs in the spring were made by the living matter called protoplasm, which is in young cells of the cambium (page 13, fig. 12, R), that lies between the bark and the wood. The great point is to join this living substance of the two stems together. I will now show you how to do this.

The stem I have chosen is a wild Rose, and the cutting that I am going to graft upon it is a cultivated Rose. I have taken, you see, a slanting piece off one end of the cutting, and I will now take exactly the same-shaped slice off the stem, so that they stand exactly one upon another. I shall now tie them fast together by twisting this piece of worsted tight round.

You see I have cut the stem and the cutting just above a joint, where you know a little bud lies. There are no leaves at the top of the cutting. It is sufficient to have two or three joints, whose leaves are just beginning to appear or swell. If the two parts fit exactly, you would soon be unable to find out where they were grafted together, but if they do not fit, the stem and the graft will soon die, because the sap will not be able to pass through up to the leaves.

In Italy, some gardeners pretend that plants belonging to different families can grow on the same stock; for instance, they will sell an Orange stem, out of which Jessamines, Roses, and Honeysuckles all grow together. I will tell you how they manage to do this trick. They scoop out all the centre of the soft Orange stem, and then put in the stems of the plants I have named, which send down their roots into the earth, and so appear to grow out of the Orange stem.

TENTH LECTURE.

ON FLOWERS, AND WHY SOME HAVE COLOUR, SCENT, AND HONEY.

THREE months have passed since I gave you my last lecture. It was then spring time, and the buds were only just beginning to open out; now the woods, hedges, and fields are covered with green leaves and summer flowers. I have put off giving you this lecture, as I thought it would be better to ask you to meet me in the summer, when I could show you some of the wild flowers that I mentioned in the winter, and those you are going to hear about in my lecture to-day.

You will remember this curious plant, called the Fly-trap (*Drosera*), because its leaves have the power of catching flies. I gathered it yesterday on the moors at Ilkley (fig. 48). As Ilkley is so near Leeds, I hope your parents will take you there this summer on some holiday, when you will be able to gather some of these wonderful plants for yourselves. You can dry and press a few specimens while they are in flower, and examine the leaf with those little magnifying glasses which I hope you will soon receive from me as prizes, or be able to purchase for yourselves, as they are only tenpence each. The flower of the Fly-trap stands on a tall thin stem about three inches high. As this plant (*Drosera*) requires the purest air, there will be no chance, I fear, of your being able to make the plants you gather at Ilkley grow in your own homes. If you follow the directions I am now going to give you, I hope you will be able to discover the place where they are growing. Walk up the high road which leads to the moors and the little white house, called Ilkley Wells; turn to your left towards Ben Rhydding, keeping on the same level until you find a pond half dried-up, with grasses and moss. At the edges of the pond, growing out of the moss, called *Sphagnum*, you will see little tufts of the Fly-trap. At the end of the lecture you shall look at this plant through a hand-glass, and you will see the little bright drops or glands that shine like dew-drops. The plant is sometimes called the Sun-dew, be-

cause of these drops. Dew, you know, only falls on plants in the morning and evening, so that these cannot be dew, as the leaf is always covered with them. You will find that these leaves have caught several little insects, which would slowly have been dissolved into a juice that the plant feeds on, by a kind of gastric juice which comes out of these little glands. It has been proved by Mr. Cambry, an American botanist, that the Drosera can digest beef if very little pieces are placed upon the leaf!

FIG. 48.

Drosera, or Round-leaved Sun-dew.

I brought this bouquet of wild flowers (fig. 49) from Tenby, a sea-side place in South Wales, as I wished to show you what a lovely bouquet can be made of wild flowers, ferns, and grass. They were nearly all gathered within a mile of Tenby, and most of them in a sandy field where no one would have walked for the pleasure of walking, as the grass was rank, full of weeds and thistles. But you must know that these are the kind of places botanists like, because they know that there all sorts of curious flowers will flourish. I wish I could also show you a bouquet from Covent Garden Market made of choice green-house flowers, deprived of all their leaves, packed tightly together in the form of a cauliflower; because I am sure you would think with me that my wild one is much more elegant. The leaves show off the flowers and prevent their looking gaudy. Grasses, though colourless, are very graceful. The flowers in a Covent Garden bouquet are not only deprived of their leaves, but of nearly all their stems, except about an inch, to which long pieces of wire are fastened. As no water can pass up these wires to the flowers when they are thirsty, they wither and die in a day or two. These false stems make the flowers so heavy that they soon become a burden to carry. An unnatural bouquet of this kind sometimes costs two or three pounds!

Should you ever meet with the plant in the wild bouquet that looks like a Thistle, called Sea Holly, family *Umbelliferæ*, take care of it, for it is a curious and beautiful plant that

FIG. 49.

will not wither for months if put into a dry vase. Grasses, too, are very ornamental in the winter; they should, of course, be gathered when in flower. I am sure you have

too much good taste to admire grasses which are sold coloured red, blue, &c., by means of some dyes.

FIG. 50.

Orchis pyramidalis.

This beautiful Orchid, which I hold in my hand, called *Pyramidalis*, the most beautiful of the Orchids that grow wild in Great Britain, was gathered near the field I have just described.

The flowers which Orchids bear are most curious and interesting. I was therefore delighted to find one, as I wished to tell you something about these flowers to-day.

I also made a small collection of Grasses, as they are now in full bloom. The flowers that grasses bear have neither colour, scent, nor honey, except one called Sweet Vernal Grass (*Anthoxanthum odoratum*), which gives to a hay-field the delightful perfume we all know so well. Their shapes are very elegant, keep for months, without water, and therefore make a pretty ornament in winter.

Unless plants bore flowers we should have neither fruit nor seeds, and without fruit or seeds neither man nor animals could live. Every gardener ought to know how fruit and flowers are formed, and how seeds grow ripe, or set, as gardeners say. If you wish to gain this information, you must first learn the names of the organs which a perfect and complete flower has, and how these organs are placed round the flower stalk or stem. A botanist knows the exact spot where each organ of a flower should stand, and therefore can tell the name of the organ, however altered its shape may have become.

I have endeavoured to show you during my lectures that every organ in a plant is only an altered leaf and stem. I am now going to explain how each organ that a flower possesses is only a leaf and stem whose colour and shape have been changed. The leaves in a flower-bud are folded up nearly in the same way as they are in a leaf-bud. But when the flower-bud opens the leaves keep close and form circles of leaves one within another round the flower-stalk. The joints in the flower-stalk out of which the leaves grow are scarcely separated at all, because the little stems that come between

them do not lengthen as they do when a leaf-bud opens out into a branch.

The first and outside circle of the leaves of a flower is called the 'cup,' because it holds and protects all the other organs (Latin name, *calyx*). The leaves which form this cup or calyx are called *sepals*, and generally remain green. I must tell you that botanists do not consider green as a colour. The next circle is called the *corolla*. These leaves have generally a bright colour, and are called *petals*. The leaves in the third are

FIG. 51.

Wild Rose.

FIG. 52.

Red Rose.

called *stamens*, and those in the fourth and last circle are called *pistils*.

These names are written down for you to take home. By degrees you will learn to know them, and their Latin names.

You can see all the organs I have just mentioned in these two large models which take to pieces. One is a flower called a Pink, and the other a Sweet Pea.

Some people cannot believe that stamens and pistils are only altered leaves and stems, until they find that these organs change in certain flowers into coloured leaves, if the plant is put into very rich soil. Here is a wild Rose which I gathered in a hedge. Let us see what organs it has. You see it has a green calyx, a circle of coloured leaves, and a great many circles of tall yellow stamens, and in the centre of the flower there are a great many short pistils. Now, we will examine a cultivated Rose which has been fed on very rich soil, and brought up in a greenhouse. If we take it to pieces we shall not find one stamen—nothing but a circle of red leaves, with perhaps a few pistils. This smart rose cannot bear fruit and seeds, but the wild Rose, that has led a healthy life in the open air, and had plenty of plain wholesome food, will bear fruit and seeds upon which the poor little birds can feed in winter when the snow covers the ground.[1] A Rose will sometimes consist of nothing but green leaves.

The two organs that give us the fruit and seeds are the stamens and pistils. I will first explain how a stamen is formed from the leaf and stem. We will take a stamen out of the model of the Sweet Pea (fig. 53). The use of a stamen is to hold the pollen-grains, which are very tiny little yellow balls, that look to the naked eye like yellow powder. I have some pollen on a card, which you shall look at through the hand-glass at the end of the lecture. The pollen-grains contain that living matter which forms all the new parts of a plant in the spring, called the 'protoplasm.' The pollen is always kept in a case called the *anther* (*b*), which stands at the top of a stalk (*a*).

FIG. 53.

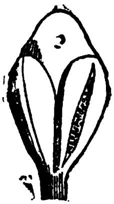
A stamen. D, pollen-grains; *a*, style or stem; *b*, anther or pollen-case.

This pollen-case is made of a leaf, the sides of which are folded so as to make a closed case. The line which appears to divide the pollen-case into two parts, is the middle

[1] A green Rose is to be seen at Kew (see page 157).

line or rib in the leaf. When the pollen-grains are ripe the pollen-case opens to let them fall out. This long stalk (*a*), on which the pollen-case stands, is only the stem belonging to the folded leaf. In this picture you can see the pollen-grains (D)

FIG. 54.



Stamen of *Pinus sylvestris*, opens down where the dark line is drawn.

FIG. 55.

Stamen of Barberry, turns up to let out the pollen.

FIG. 56.

Stamen of Bay Laurel; one door is open, and the pollen is falling out.

FIG. 57.

Stamen of Erica or Heath, showing holes in the pollen-case to let out the pollen (*Ericaceæ*).

FIG. 58.

Stamen of Rhododendron, showing hole to let out the pollen (*Ericaceæ*).

FIG. 59.

Top of pistil called 'Stigma.'

Middle part is called the 'Style.'

Seed-case at the bottom where the swelling comes.

Pistil of Lily.

falling out of the stamen through the outer edge, which is open. Stamens have very different shapes in different flowers, and open in many curious ways, as is shown by the above illustrations of stamens (figs. 54, 55, 56, 57, 58).

A pistil is a box which holds the seeds. This box is made of a leaf that is folded into different shapes in different flowers.

FIG. 60.

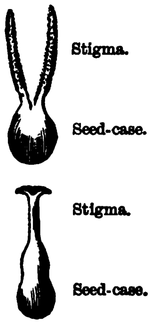


FIG. 61.

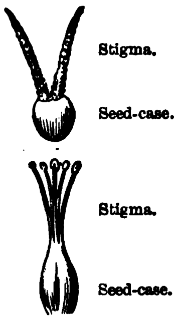
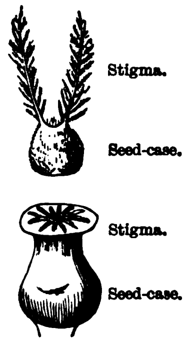


FIG. 62.



The seeds always lie in the lower part. The top of the pistil that comes out of the flower is always rough and sticky, directly it becomes ripe (figs. 59, 60, 61, 62). We will take the pistil out of the model of the Sweet Pea, which is shut up in the part of the flower called the keel (see page 53, fig. 38). Pistils, I am sorry to say, have a great many Latin names. The pistil of the flower in the Pea family is called a *pod*. We will first examine the outside of the pod (fig. 63). I think a pod looks very like a folded green leaf. You see the pod or pistil is quite shut up, like a box. This must be a ripe pod or pistil, as the long narrow top is rough. Now, we will burst it open down the side. Here are five little seeds. One model of a seed will open, so that you can see the little germ or plant. All the seeds look very plump and healthy except one, which looks withered and soft, and has no little plant inside it. There cannot be a little plant or germ in the seed unless some ripe pollen has been able to enter it. When the top of

FIG. 63.

Pistil or Pod of Pea.

the pistil is ripe, the pollen that falls upon the top of the pistil forms a tube which grows until it reaches a little spot in each seed called the *Ovule.* In this model you can see a pollen-tube attached to each seed.

We must now find out how the pollen is carried and placed on to the pistil. As the pistils and stamens are so near together in a perfect flower, people used to think that some pollen would naturally fall on to the pistil, but it is often found that the stamens and pistils are so curiously placed that the pollen cannot enter the pistil, not even when they are shut up close together, as in the Sweet Pea in that part called the *keel.* If you examine a Buttercup with your little magnifying glass, you will find that the stamens are placed so that the openings to the pollen-cases are turned away from the pistil; therefore, when the cases burst, all the pollen will fall outside the Buttercup. Not a grain will fall on to the pistil. All the flowers belonging to the Buttercup family are made in the same way. Some one must carry the pollen from one Buttercup to another, or else from a Buttercup to a member of the Buttercup family. It would be of no use, for instance, to place the pollen of the Buttercup on to the pistil of the Sweet Pea, because the Sweet Pea is not a member of the Buttercup family, and therefore the Buttercup pollen would not make the seeds on the Pea set.

In the flowers that belong to the Pea, Pink, and Fuchsia families, the pollen-cases burst before the pistils are ripe, so that none of the seeds in these flowers can receive pollen from their own stamens. I could mention hundreds of flowers besides these in which the seeds would never receive any pollen unless it was brought to them.

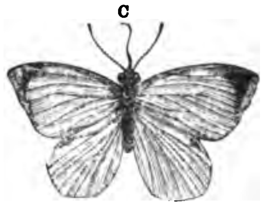
Who do you think is able to carry the pollen-grains and place them on exactly the right flower, so gently that the flower is not injured? If you look into this box, you will see some of the beautiful little servants who do this delicate work. I will give you their names—moths, butterflies, bees, &c. These pretty little creatures like scent, honey, and the beautiful colours that flowers have, as much as we do. No doubt they are able to discover their own particular flower, either by its colour or by its scent. A gentleman proved by

the following experiment that insects do know one colour from another. Several pieces of white glass were placed over pieces of different-coloured papers. Honey was put on the top of each glass. One kind of insect took the honey from a certain colour, say blue, another from white, another from a red piece of glass, and so on. The colours were continually moved into different places, but each insect always kept to its own favourite colour, and went wherever it was placed.

FIG. 64.

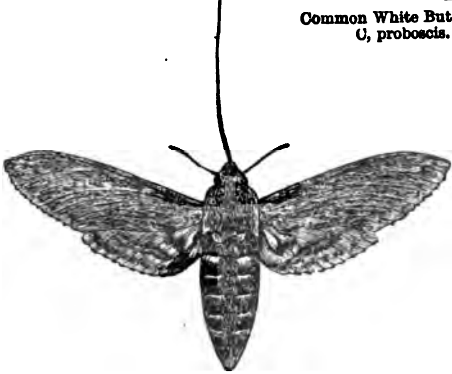
Bee. A, proboscis.

FIG. 66.



Common White Butterfly.
C, proboscis.

FIG. 65.



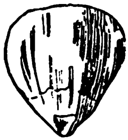
Convolvulus Hawk Moth. B, proboscis.

We must examine these little messengers to find out how they carry the pollen. You see that their heads and legs are covered with hairs; these hairs will carry the pollen like a brush. Every one of them has a tube coming out of its mouth, which looks like a tiny elephant's trunk. It is by means of this tube, called a *proboscis*, that the insect takes out the honey from a flower. In some insects the proboscis is much longer than in others. A death's-head moth has the

longest. The humble-bee has a longer proboscis than the hive-bee.

The place where the honey or nectar is kept in the flower is called a *nectary*, or a honey-gland, and bees carry the nectar home and make it into honey in their hives. The honey-glands are placed in different parts of flowers. If you pull out a coloured leaf of the Buttercup, you will find the little honey-gland just at the bottom of it.

FIG. 67.



Buttercup Petal.
A, honey-gland.

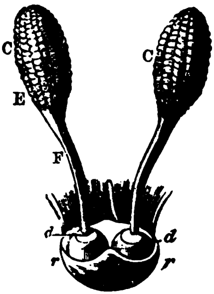
When an insect visits a flower it stands upon the most convenient and comfortable part it can find, where it can easily put its proboscis down into the honey-gland. A bee would naturally stand most comfortably on the centre of a buttercup, and while putting down its proboscis to search for honey, its body and legs would soon become covered with pollen-grains. The pistils will very likely be ripe in the next buttercups it flies to; then the ripe pollen-grains that are shaken off the hairs will enter the pistils and be carried by the pollen-tubes down into the seeds. This is the way that insects fly from flower to flower, leaving the pollen and taking away the honey, which well repays them for all their labour. On a fine summer's day, when you go into the country, you must watch, and you will see that every coloured flower is visited by some kind of insect, and if you examine the tiniest flower with your little glass, you will find a little workman busy within. If you listen as well as watch, you will hear their voices, for they fill the air with a soft murmuring noise that sounds as if they were talking together and enjoying their work.

The honey-gland in some flowers, like the Honeysuckle, is very long and deep; the insect, therefore, that visits these flowers must have a long proboscis. In hot countries, where wild flowers grow to be very large, the honey-glands are so long that only humming-birds with their long slender bills can take out the honey and carry the pollen.

I have told you that stamens are always placed round the pistils in all perfect flowers, except those belonging to the Orchid family. Orchids have generally only one perfect

stamen which stands on the top of the pistil. The pollen-case, or anther, of this stamen has no stalk (O), and contains two most curious objects that look like clubs. These clubs are the pollen-grains, which are tied together in little packets by elastic threads (I). Fastened to the foot of each of these pollen-clubs there is a little sticky cushion (*d*, fig. 68), which stands on a bag (*r*) (which is also filled with

FIG .68.



Two pollen-clubs as they stand on the cushion or top of the pistil. C, C, pollen-clubs showing the pollen-grains fastened together by the elastic threads that run down between them and unite at the bottom into a kind of stem marked F; *d*, is the wonderful piece of skin fastened to the end of the pollen-club that comes out of the cushion and fastens the club to any object; *r*, is the cushion or top part of the pistil.

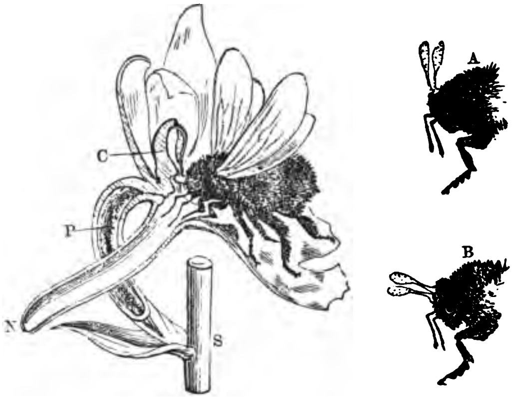
FIG. 69.

Spotted Orchis Flower, or *Orchis maculata*. A, stamen or anther in single flower; C, cushion or top of pistil on which the stamen stands; M, mouth of honey-gland; L, lip or leaf on which the insect stands; N, honey-gland hidden by lip; P, pistil where the seeds lie; O, stamen or anther showing the two pollen-clubs; H, cushion or top of pistil; S, sticky part of pistil beneath the cushion on to which the ripe pollen-grains stick, and then pass down into the seeds that lie in the long twisted pistil P, fastened to the flower-stalk S, as seen in fig. 70; U, mouth of honey-gland.

a very sticky substance). This bag is the top of the pistil, and projects so much that it quite conceals the sticky part of the pistil under it, through which the pollen must enter. None, therefore, of the pollen that falls can touch the pistils and get down to the seeds. If you look at this picture of a single Spotted Orchis flower (fig. 69), you will see the anther-

box (A) standing inside a little hood (B) made to protect the pollen-clubs from cold and rain. This hood is formed by two of the bright-coloured calyx leaves. The calyx leaves are never green in Orchids. Orchids have also only three leaves in the corolla as well as the calyx. The large leaf (L) that spreads out in front, below the dark opening (M) which is the mouth of the honey-tube, is the upper part of the third leaf of the corolla, and the bottom part of this large leaf near the stalk is folded into the long honey-tube (N). The part of the leaf that spreads out is called the lip, a very good name, because it

FIG. 70.



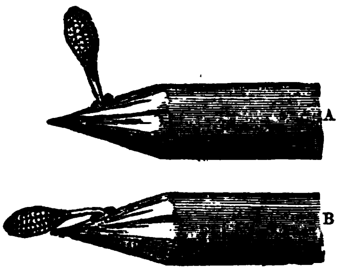
An insect standing on the front leaf called the lip; its head has struck against the cushion, and the two pollen-clubs have sprung out and are becoming fast to the top of the head, as seen in insect marked A. In insect B the two clubs have bent down, so that on entering another flower they will strike and break against the sticky pistil under the cushion, and the pollen-grain will be held fast and pass down to the seeds.

leads into the mouth of the honey-tube. The lip is a very handy place for a large moth to stand, either to rest, or to send down its long proboscis into the long honey-tube.

The honey is so curiously placed in this honey-tube that it takes an insect at least thirty seconds to suck it out. We will fancy we are watching the moth in the picture (fig. 70), in order to discover how he will manage to carry away the two clubs (fig. 68) with the pollen-grains, which are tied up so carefully into little packets by a kind of elastic thread (E). I expect—don't you?—that as he enters the flower his head will strike the anther and burst these little packets, so that

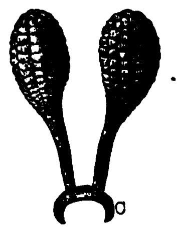
the pollen-grains will fall and cover his head and body. You see we are mistaken. His head does not touch the clubs, it only presses down the bag on which the clubs stand. Directly his head touched the bag, the two clubs sprang out of the sticky bag, and are now standing bolt-upright on his head (A). Poor fellow! how uncomfortable he must feel! He little knows how queer he looks. You will now see that a most wonderful thing will happen. The two pollen-clubs are gradually turning and altering their position. Now they are lying down (B) instead of standing up, and stick faster than ever, because the sticky substance in the little cushions (*d*, *d*, fig. 68) I mentioned has become as hard as cement, when they fall into a line with the head. The clubs, I know,

FIG. 71.



The pointed end of a pencil which has been put into the honey-gland of a Spotted Orchis Flower. A, shows how a pollen-club stands upright when it first sticks to the pencil or any object; B, shows the position into which the pollen-club falls in about thirty seconds.

FIG. 72.



Pair of Pollen-clubs on saddle-shaped cushion of *Orchis pyramidalis*.

were exactly half a minute in moving, because I counted thirty seconds. I will now tell you why the clubs are made to move in this wonderful manner: when the moth visits another flower, they will be placed just so that they can strike against that part of the pistil that lies under the cushion where the pollen-grains enter and go down to the seeds. Had the clubs remained bolt-upright, they could not have struck the pistil.

I will now put a fine-pointed pencil into the honey-gland of this fresh Orchid-flower. You will find that a club has stuck fast to the pencil. I will count thirty seconds, and by

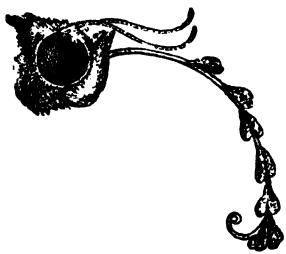
that time the club will have fallen straight in a line with the pencil, just as it did on the moth's head (fig. 71, A, B).

If I had time, I could tell you of many still more wonderful contrivances which other Orchids have, that enable moths to carry the pollen from one Orchid to another. I hope some day you will read the book that I have studied, which will tell you these interesting facts.[1] The two clubs in the *Orchis pyramidalis* (fig. 72) stand together on a little sticky saddle-shaped cushion (C). This little sticky saddle, on which the two clubs ride, clasps the proboscis of the moth when it enters the honey-tube.

In this other picture (fig. 73) you can see a moth's head, with its proboscis, on which seven pairs of clubs are riding.

There are a great many plants that have curious-shaped flowers, which you might mistake for Orchids; but you can always tell an Orchid by putting a needle, or anything with a fine point, into the nectary of the flower, as I did. If the flower is freshly gathered, the clubs will come out, and stick fast to the instrument.

FIG. 73.



Head of a moth, showing its proboscis upon which seven pairs of pollen-clubs are riding, which have a saddle-shaped cushion, as seen in fig. 72.

Orchids are endogens. The leaves of an Orchid are often spotted, and are always made like those of grass. The woody fibres that make the skeleton run in straight lines from one end of the leaf to the other.

Why has so much trouble been taken to prevent seeds from receiving the pollen from the stamens that grow on the same flower? Because it is found that seeds that do not have pollen from *another* flower are small in number and size, and are less healthy.

This world owes a great deal of its beauty to flowers. They teach us to admire colour and form, and show us how these colours can be most exquisitely blended together.

[1] Dr. Darwin's *Fertilisation of Orchids.*

Their scent is not only delightful, but healthy, as it purifies the air by sending out a substance called *ozone*.

Insects, which depend upon flowers for their food, are equally beautiful in form and colour, and quite as interesting to study. No one can thoroughly understand flowers unless they know a great deal about the construction and habits of insects. Their history is now being delightfully written by Sir J. Lubbock and other scientific men.

ELEVENTH LECTURE.

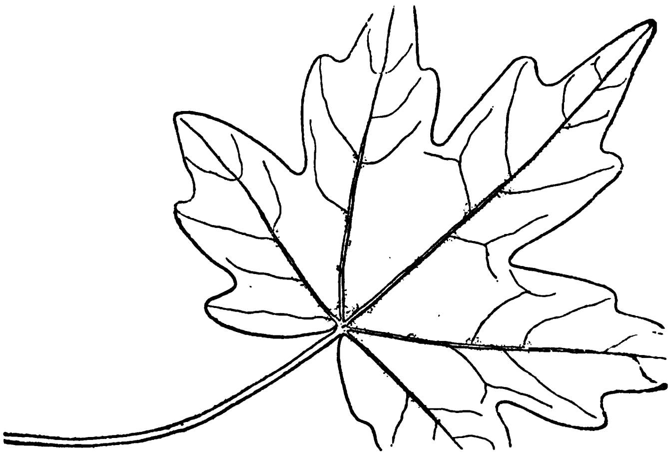
ON THE BEAUTY OF THE AUTUMN AND THE USE THAT INSECTS ARE TO PLANTS.

I HAVE again allowed three months to pass before giving you another Lecture, as I wished to wait until the autumn had come, so that we might notice together the changes that take place in plants at this season of the year. Yesterday I went to Mulgrave woods, near Whitby, where we are now staying, to try and gather some autumn flowers, to bring with me to-day. A few Harebells, Ragged-robins, and wild Geraniums were all I could find. As I drove home through the lanes, I found that the flowers on the wild Rose-trees in the hedges had all changed into fruit—these bright little berries, called Hips, which, I told you, birds feed on in the winter. The branches of the Hawthorn trees were also laden with these scarlet berries, called *haws*, so that the hedges looked quite gay. Though flowers have nearly passed away, the country is still very lovely, as a great many trees look much more beautiful now than in the middle of summer, when their leaves were all green. Some leaves, as they grow old and give up work, put on the gay colours that flowers are decked with. This is the best time of year for admiring the shape, as well as the colour, of leaves, as the living and fleshy part that lies in the cells between the upper and under skin disappears and passes into another part of the plant that is still alive. The leaf, by this

means, becomes so thin, that its skeleton can be seen through the gay-coloured skin that covers it.

I have made a small collection of the leaves of different plants, and gummed them on to this sheet of white cardboard. The fruit which belongs to each leaf is placed by its side, with the name of the plant to which they belong. I recommend you to make a similar collection, as you will learn a great deal by this simple and pleasant method. By degrees you will be able to recognise a tree by its leaves and fruit; and, above all, you will be taught the exquisite beauty of their form and

FIG. 74.



Maple.

colour. Architects, in all ages, have copied fruit and leaves and had them carved on stone, to ornament their churches and buildings. The Vine, Geranium, &c., have always been great favourites. I have brought a beautiful book,[1] which shows you designs for stonework, woodwork, and wall-papers, made from various plants.

Plants, you know, are divided into families. It is sometimes possible to tell what family a plant belongs to by the shape of its leaf. For instance, a great many plants that

[1] *Plants: their Natural Growth and Treatment.* By F. E. Hulme.

belong to the Maple family (*Aceraceæ*) have leaves the shape of a hand. The ribs which help to form the skeleton spread out like fingers. Here is a leaf of the Maple (fig. 74), and one of the Horse-chestnut (page 153, fig. 125).

The fingers of some members of this family are much more divided and more numerous than those of the Maple. Still, they are united together at the bottom by a part of the stem, which represents the palm of the hand. A Latin name is given to these leaves, that means 'hand-like' (*palmata*).

Some leaves gain much more beautiful colours in the autumn than others. The leaves of the wild Geranium are changed to a rich scarlet colour; the Rose family also have a beautiful rosy tint; the leaves of Beech-trees become quite a brilliant orange. It is said that the reason a Beech-tree retains its coloured leaves all through the winter is that they fall over the young bud, and guard them from cold.

The autumn is also a most interesting time, because we can then watch and see how the flower changes into the fruit, that is formed on purpose to protect the seed. We must remember that all the toil and labour of a plant, from the time when the leaf-buds open in the spring, is to store up food for the young flowers and leaf-buds next year, and prepare food for the flowers while they are changing into fruit and seeds. The seed is of course the most important part of the plant. Without seeds we should have no bread. Wheat, Barley, Oats, Rice, &c., are all annuals, and therefore require to be fresh set every year.

It pleased me very much to find a wild Geranium still growing, as I wished to let you see the great beauty of its leaves and flowers, and tell you its history. All Geraniums and Pelargoniums can be known by the curious way in which the fruit is placed round the stem. Fortunately we shall find flowers and ripe fruit all growing together on this little stem, so that you will be able to see the different changes that take place while the fruit and seeds are being formed from the flower.

You must first examine one of the little flowers (fig. 75, A) through a hand-glass, and you will find that the coloured leaves (*corolla*) are beautifully tinted, have some tiny hairs, and a

dark vein or line in the middle of each, which seems to lead down into the inside of the flower. These stems (F, G) on the top branches do not look as if they had ever been part of a flower, such as the one you have been examining, because they have lost their beautiful dress (*corolla*), which made them look so bright and gay. Their coloured leaves quite

FIG. 75.

Herb Robert, or Cranesbill. A, flower stalk; B, calyx folded round the five carpels; C, four ripe carpels drawn up and ready to burst and let out the seeds; D, five calyx leaves opened out to allow the five carpels to escape; E, buds.

concealed this curious-looking stem, that has the shape of a crane's bill, and gives this wild Geranium its common name of Crane's-bill. The coloured leaves hide also the five little carpels which stand round the stem. Each of these little carpels is a folded leaf, that holds one seed, so that each carpel is really a fruit. If you look closely at these five little car-

pels, you will see that they are covered up by the calyx or green cup (B), which has folded round them to protect them while they are young and tender. Directly the seeds are ripe, the cup will unclasp them, and set them free (D). The little thread or style (S) that fastens each seed or carpel to the stem grows very short, and drags them up as if from their roots, until they reach the top (C); then the carpels burst open with a jerk that makes a noise, and out falls the little seed to the earth, to grow up a new plant next summer. If you take any Geranium or Pelargonium with ripe fruit early in the morning, before the dew has ceased to fall, and place it in the hot sun, you will see the little carpels being drawn up by the thread, and hear a snapping noise when the carpels burst, and the seeds fall out of them. Do not forget to notice the elegant shape of the leaves, and how some of them have changed in colour.

The wild Geranium was a great favourite of a very good and learned man, named Sprengel, a German, who was born in 1766, at Bolderkow, in Pomerania. He was brought up to the medical profession, and educated by his father, a clergyman. At fourteen he knew Hebrew, Latin, Greek, and some modern languages, and became so distinguished a man that every country in Europe offered to confer some honour upon him; but as he worked to find out and show the truths and wonders of nature, and not for distinction, he refused every honour and worldly advantage that was offered him. As a child he was very fond of flowers, and his great delight when he grew up was to study the beauties of nature, and prove that the Almighty makes everything for some wise purpose. This religious feeling made him examine every line and hair on the wild Geranium, and led him to discover that flowers have colour, scent, and honey, in order to induce insects to visit them, and carry the pollen from flower to flower. The lines on the petals directed the insects to the place where the honey is kept, and the hairs are for the protection of the honey. Before Sprengel lived, botanists had very curious ideas about the use of honey. One thought it injured the flower, and for that reason bees came to carry it away. How rejoiced Sprengel would be, did he live in these days, when

so many new discoveries are being made about the habits of insects and flowers !

Sir John Lubbock has lately been telling us why flowers go to sleep—that is, shut up their calyx and corolla in the day-time and open them in the night, when everything else is sleeping ; why some stems are very slippery, have thorns, and are covered with hairs ; and why honey is sometimes placed in the stem as well as the flower. I will try to relate some of his interesting stories, which you must one day read for yourselves. There are insects, called ants, whose visits to plants would do a great deal of harm instead of good, because they have not the power of carrying pollen from one flower to another like moths, butterflies, bees, &c. All they want is to eat the leaves and honey. These ants cannot fly, they can only creep up the stems. Now, if the stems are slippery and covered with hairs, they cannot creep up them. The Foxglove has a most curiously shaped flower, as you can see by looking at the one I hold in my hand. The five coloured leaves which make the corolla are all fastened together so as to form a closed box with a lid. The stamens, pistil, and honey are shut up safely inside. Though ants are wonderfully clever, they cannot manage to get admittance to this box. There is only one insect that knows the secret and can open the door—that is a humble-bee. There are ants called 'leaf-cutters,' who are most destructive to plants. They soon kill them by eating up every leaf. There is, fortunately, another sort of ants, who devote their time to killing the leaf-cutters. An American Acacia of which leaf-cutters are very fond, is fortunately provided with sharp hollow thorns on the stem. At the bottom of each leaf there is a little gland like a cup, which is filled with honey. Myriads of ant-killers live in these hollow thorns, which serve as their houses, and drink the honey out of the cups. Their lives are devoted to catching and killing any leaf-cutter who ventures to attack their homes. A large army of these little ants is constantly wandering over the leaves in search of their enemies, and as the ants are on duty both night and day, they manage to accomplish a great amount of slaughter. A scientific gentleman named Forel watched an ants' nest, and found that dead insects

were brought in at the rate of twenty-eight a minute, or more than one thousand six hundred in an hour. These ants are very useful in preventing animals that live on plants from stripping off the leaves of these trees. Sir John Lubbock has even still more wonderful stories to tell about the habits of ants and other insects.

There are a great many flowers which sleep by day and are awake during the night. These flowers are generally white, and have a very powerful scent, so that insects may be able to find them out in the dark. I will give you the history of one night flower called the Nottingham Catch-fly (fig. 76). This flower grows on the Dover cliffs in May. It remains in bloom for three nights. If you saw it during that time, by day, you would think it was an old withered flower, for it then closes its petals and hangs down its head until evening comes. Then I should like you to see what a wonderful change takes place. The white leaves of the corolla open out, and a strong scent fills the air. This flower has ten stamens which are placed in two circles of five each. The five stamens in the outer circle open, and, for two hours, quite rise out of the flower. At three o'clock in the morning, the pollen-cases burst. When the pollen has all fallen out of the cases, the scent goes quite away, the petals, or the white leaves of the corolla, close in and fold up in such a way that the flower looks again withered and dead. If you watch again the second night, you see the flower open again at the same time, the scent comes out and the second row of stamens project from the flower, the pollen-cases burst, and the pollen falls each time outside the flower, so that none of it reaches the pistil. The third and last night of the flower's

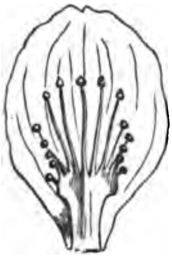
FIG. 76.

Nottingham Catch-fly, Chickweed Family, *Silene paradoxa*.

life is spent in opening at the same time, sending out the same scent, but instead of stamens appearing, the pistil has grown big and ripe, and stands up in the middle of the flower, so that a moth that has just come from paying a visit to another Catch-fly, whose anthers have just burst and covered him with pollen, must strike against the pistil and cover it with pollen.

I must not forget to show you this curious flower, called the Grass of Parnassus, which I gathered on the cliffs at Whitby. It is not a Grass at all, as you will see directly by examining the leaf. On each leaf of the corolla there is a little cluster of green balls, like the precious stones called emeralds. You shall look at them through a hand-glass at the end of the lecture. They are honey-glands. This little plant belongs to an interesting family called Saxifrages, the roots of some of which are said to push themselves into the crevices of stones, swell when they become wet, and so break up the stone into soil ready for other plants to grow in. There is scarcely any hot or cold country where some of them are not to be found growing either on walls or in boggy, sandy places, such as are to be found on the Whitby cliffs. You can take some of these plants home and examine them. I fear they will not grow in a smoky town. Wild flowers cannot bear smoke and dirt.

FIG. 77.



Petal leaf of Grass of Parnassus.

Before I finish my lecture, I must tell you what I know; you will be pleased to hear that your window-boxes were very much admired when the prizes were given away in July. I was rejoiced to find that a great many boxes that gained prizes had come from low and dirty parts of the town. I hope that the little magnifying glasses, that were given for regular attendance, will prove useful, and help you to understand the organs of a flower. I wish you would all write me a letter, giving the names of the plants your boxes contained, and a little history of how you reared them.

Things taken to the Lecture.

Wild Geranium.
Flowers and fruit placed upon cards to be sent round to the children for examination with a hand-glass.

TWELFTH LECTURE.

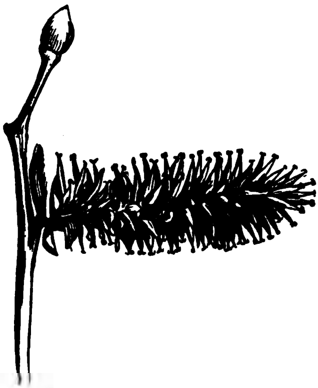
ON PLANTS THAT BEAR IMPERFECT FLOWERS—WHY THE VISITS OF INSECTS TO FLOWERS ALTER THE SEEDS, SO THAT THEY DO NOT ALWAYS GROW UP EXACTLY LIKE THE PLANTS FROM WHICH THEY ARE TAKEN—COMPOSITE FLOWERS, AND HOW THESE FLOWERS CAN BE ALTERED BY CULTIVATION.

After hearing the information I have to give you to-day, I think you will all feel that it is impossible to be a good gardener unless you understand a great deal about flowers and how they are made. All the flowers I have so far described have been perfect, because they contained stamens and pistils. To-day you must be told something about plants that bear imperfect flowers, such as you can see growing on an Oak tree, called *catkins*. One flower has only stamens, the other only pistils, and these two flowers grow side by side on the same branch. No insects visit Oak flowers, because they have neither colour, scent, nor honey. The pollen is carried from the stamens on to the pistils by the wind.

There are a great many plants besides the Oak that bear imperfect flowers, but in these plants the flowers do not live on the same tree as they do on the Oak. They are quite separated one from the other. The pistilline flowers live on one tree, and the staminiferous on another. These plants are called by a Greek name that means 'two-housed' (*diœcious*). The Willow is a diœcious plant, and grows in sandy places near rivers and pools of clean water. About the middle of last March I gathered both the staminiferous and pistilline flowers off a Willow, called the Sallow (*Salix Caprea*), at Harrogate, near some quarries. The yellow staminiferous catkin-flowers look like little yellow brushes (fig. 79); they come out

before any leaves appear, and make the tree look very gay. The pistilline catkins are the same shape, but are of a dull green hue (fig. 78). The yellow catkins send out a fine scent at night which makes the Sallow a great favourite of moths. Moth collectors place a sheet under the tree, and when night comes go and shake the branches to make the moths fall on to it, who become quite stupefied by the great quantity of honey they have taken. The yellow catkins are often called Palms in England, as they were carried in churches on Palm Sunday by people who could not get the real Palm branches that are carried in the East to celebrate the entry of Jesus into

FIG. 78.



Pistilline flower, no scent, dull green.

FIG. 79.

Staminiferous flower, yellow, and sweet-scented, of the Sallow (*Salix Caprea*).

Jerusalem; but a Willow and a Palm are very different trees. The Willow is an exogen. A fresh ring of wood grows round the stem every year, and there are a great many branches in its leaves. A Palm is an endogen. Its stem never grows bigger, but very tall. A Date Palm often grows two hundred feet high. Though the Willow and the Palm are very different in many ways, they are both diœcious plants—that is, their flowers grow on different trees. The Date Palm bears immense clusters of staminiferous flowers, as you may fancy when I tell you that one cluster contains twelve thousand blossoms.

The following story, told by Dr. Carpenter, shows how even war may be prevented by a knowledge of plants. The Date Palm tree grows in Arabia, and bears a fruit called a date, upon which fruit a great many Arabian tribes depend almost entirely for their food. As cold and damp often kills the pollen, the Arabs, when a good year comes, collect it and keep it for the next spring, should it prove a bad season. They also gather clusters of the staminiferous flowers and hang them over the pistilline. These Arabian tribes often quarrel and attack each other, and when they invade each other's countries, they will cut down the staminiferous trees, as they know that that is one of the most cruel things they can do. The prince of the city and territory of Bassora having heard that the Grand Signior intended to invade his dominions, sent him word that if he came he would cut down all the pollen-bearing Palms, so that there would be no food for his soldiers during the siege. The Grand Signior, after hearing this news, decided very wisely to remain quietly at home.

FIG. 80.

Date Palm. A, cluster of dates.

I have brought an Evergreen to show you, called the *Aucuba japonica*, or Variegated Laurel, and intend to give you its history, because it is a very handsome shrub, will put up with smoke, bears heat or frost, and is not particular as to the food it eats. All it wants is light, air, and plenty of water. As it is an evergreen, it looks best in the winter, when there is scarcely anything green to cheer the eye and remind one of the country. I think it is very properly called 'the poor man's plant.' The fruit which this evergreen bears is a bright scarlet berry, and looks very pretty peeping between the dark variegated leaves. These berries will remain from December to July, that is, about eight months of the year. The Aucuba is diœcious. About a hundred years ago a traveller first brought some of these evergreens to England

from the Island of Japan, its native country. As he did not know the nature of the plant, he only brought one sort, which had pistilline flowers (fig. 81). He was much surprised to find his evergreens never bore fruit or seeds. Fifteen years ago, Mr. Fortune, the great naturalist, was walking in Japan, when he heard some boys crying out with flowering plants for sale. He went up and examined the flowers, and saw directly that they were the staminiferous flowers that had never been brought to England. He immediately bought some of these plants, and brought them with him. Soon after his arrival at home, he wrote an account of this discovery in a scientific journal. A Scarborough gentleman, Mr. A. Clapham, after reading this account, sent to London for a small staminiferous plant, for which he paid three guineas. From this small beginning great results have come, for now there is scarcely a garden in Scarborough where Aucubas of both kinds may not be seen flourishing in the depth of winter. Nothing, as I said before, but want of air, water, and light kills them. They will even live under the drippings of trees, which destroy most plants.

These pretty little cuttings, which you see in this box, have been reared in Mr. A. C.'s greenhouse. Their leaves are beautifully variegated, but they are very delicate. Should a drop of water fall upon them, they will be blistered and rot away. This shows you how a plant strong by nature may be made very delicate by being brought up in a house where it cannot be made strong and healthy by snow and the storms of winter.

If you want to rear a plant so that it shall be exactly like the one you admire, you must take a cutting off the plant, and not take the seeds. Insects often carry the pollen from the flowers of an Aucuba that has dark leaves, and put it on the pistil in a flower on an Aucuba that is variegated. If the seeds of the variegated Aucuba were planted, they would probably grow up into dark-green-leaved Aucubas. For this reason gardeners never feel sure that seeds will grow up like the plants they came from. We have, you see, to thank insects for mixing the colours in leaves as well as for the lovely tints we find in a flower.

When you strike a cutting of an Aucuba or any plant, be sure to take the cutting off below the joint, for that part is sealed up, and the danger is lest any water should get into the stem and make it rot, or, as gardeners say, 'damp down.' The hole in the earth into which you put the cutting should be first lined with dry sand, and some sand should also be put round the stem. You should water it about once a fortnight. Soda suits plants very well. There is a great deal of soda in

FIG. 81.

Pistilline Aucuba (*Cornaceæ*). B, scarlet berries.

soap. You cannot give some plants anything they like better than soap-suds, the Aucuba particularly. The roots of Ferns contain so much soda that in England and Wales soap-balls are made out of them. Ferns, chopped up and mixed with earth, make an excellent manure for plants.

The Aucuba does not belong to the Laurel family, but belongs to the Cornel family. Gardeners have mistaken it for a Laurel because the leaves are long and Laurel-shaped, but the

Laurel has scented leaves that do not grow opposite to each other on the stem, as you will see by examining this picture of the sweet Bay Laurel (fig. 82), the only European one there is. The Laurel is a delicate evergreen, that will not stand smoke or dirt, nor will it bear to live under other trees where it receives the drippings from their leaves.

The picture of the pistilline Aucuba shows you the little clusters of berries (B) or fruit peeping out from between the leaves, which are opposite to each other (fig. 81). Of

FIG. 82.

Sweet Bay Laurel (*Lauraceæ*).

course I need not tell you that the fruit and seeds are only found in the pistilline plant. The seeds are always found in the pistil, and the pistil becomes the fruit. I must not forget to mention a peculiarity about the seeds of the Aucuba. They often 'dwell,' as gardeners call it, that is, remain, in the earth for sometimes two years before they come up, while some seeds will appear in two or three months. As a rule, all seeds grow quickest if set when they are ripe.

Cuttings of all evergreens should be taken in the autumn, as they then put out their new shoots. Plants that shed their leaves will make new shoots in the spring.

I am now going to tell you about flowers that live together in great numbers like a little colony. They are so beautifully arranged that they look like one large flower. These flowers are called *composite* flowers. I will mention the names of some of them, and I think you will find a great many old friends among them:—the Daisy, Sunflower, Dandelion, China Aster, Chrysanthemum, Marigold, Camomile, and Everlasting Flowers.

FIG. 83.

Chrysanthemum. A, ray flower.

All the flowers I have been describing, both perfect and imperfect, are called single flowers, because only one of these flowers lives on the stem or *receptacle.* The receptacle is a good name for this part of the stem, for it is here that all the food or starch is stored up on which the flower feeds.

I am glad to say I have a large model of a Chrysanthemum, so that you will be able to see every part of the flower without a magnifying glass. You would, I am sure, think that these large flat three-pointed leaves (fig. 83, A) are only the same coloured leaves we see in a rose or any

single flower, which make the circle called the corolla, but you will find that each leaf is an imperfect little flower, because it contains only a pistil and no stamens. What appears to be only a flattened leaf is a corolla made of three leaves instead of five (fig. 84, A, B, C), which are joined together and folded up at the bottom into a tube, in which stands the one pistil spreading out like two horns (P).

FIG. 84.

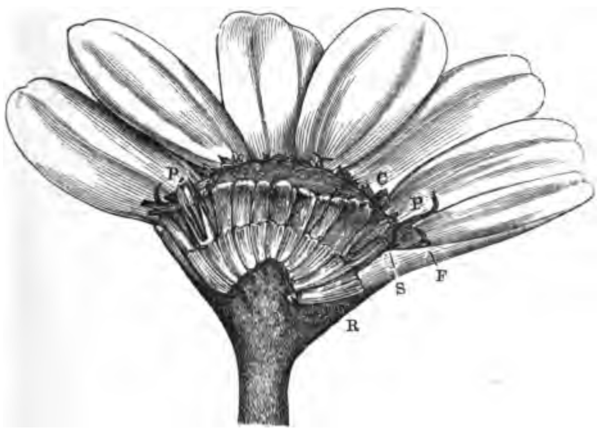
A B C

Ray Flower.
A, B, C, three leaves of the corolla joined together.

The leaves which form this outside circle are called ray flowers, because they spread out from the centre as the rays spread out from the sun. The centre part of the flower like a sun is called the disk, and is composed of at least a thousand perfect flowers. Each of these flowers contains one pistil and five stamens, surrounded by a closed tubular corolla. You can see these perfect flowers (C) in this other model of a Chrysanthemum (fig. 85), that has been divided down the middle. The front part of two corollas is cut open to show how the five-pointed pollen-cases (P, P) of the five stamens are all joined together and form a little tube. The stalks (S) which support the pollen-cases or anthers are, as you can see in the model, quite separate. The most important fact to be remembered about composite flowers is that the five pollen-cases are joined together as I have described, because there are a great many flowers such as the Parsley, Carrot, &c., belonging to another family, which all grow together on one stalk, but their anthers do not join together. Directly the pollen in the five pollen-cases is quite ripe the short little pistil grows tall and forces its way out between them, and brushes out the pollen. None of this pollen can get down through the pistil to the seeds, as the pistil is not ripe when it comes out of the flower. Tiny insects called 'thrips' wander over the top of these perfect flowers in the centre,

and their bodies carry the pollen, and place it on the pistils when they become ripe. Unless insects visited the Daisy, Chrysanthemum, and all composite flowers, they would have no seeds. Though the ray-flowers do not bear fruit and seeds, because they are imperfect, they are of great use in many ways to the perfect little flowers in the centre. First, they have colour, which attracts insects. Sometimes there is poison in the ray-flowers which keeps off another kind of insect that would eat the perfect flowers. When the weather is wet and cold, the ray-flowers will fold in, and cover the

FIG. 85.



Sunflower divided to show the perfect flowers and how they are placed on the swollen stem called a receptacle, R; F, is a ray-flower; P, P, two perfect flowers with the upper part of their corollas cut open to show how the five anthers or pollen-cases are fastened together into a tube, and how the stalks of the stamens, S, are not fastened together; C, perfect flowers before the pistils have burst through the corollas.

centre, so as to protect its flowers.[1] Not until all the seeds in the centre flowers have set, do the ray-flowers wither and fall off; then their services are no longer required. At the end of the lecture you shall examine some of the perfect flowers of a Daisy and Sunflower, gummed on cards, with a hand-glass, through which the pistils have burst, and you

[1] Watch a Daisy at night or in hot weather.

will see a little swelling round the slender stem of the pistil; that swelling is the little tube made by the stamens.

FIG. 86.

Daisy.

Flowers that belong to the Composite family are great favourites with gardeners, because they can be very much changed by cultivation; that means, by feeding them upon very rich food or soil. I have brought you a cultivated Sunflower to show you that such is the case. You would scarcely believe that this is a Sunflower, because all the perfect little flowers in the centre have vanished, or rather they have been changed into circles of flat leaves like the ray-flowers, but they have neither pistils nor stamens. People may consider this yellow rosette very pretty to look at, but it has lost the greatest beauty, that of being useful. Sunflower seeds make a good food for poultry; they also contain a great deal of oil. A Sunflower is said to throw out a great quantity of ozone, which purifies the air, because it is very strong oxygen.

Gardeners can alter a Dahlia as much as a Sunflower by cultivation. The Dahlia is not considered at all a beautiful flower when seen growing in its native country, as it has only one circle of bright ray-flowers. The first Dahlia was brought to England about eighty years ago. How different is the one I hold in my hand from the one I have described! It is a complete rosette made of nothing but coloured leaves. A Dahlia is considered to be a failure by a gardener, if the least bit of a centre, or 'eye,' as it is called, can be seen.

This is the time (October) when Chrysanthemums are in flower. I have brought some to show you. They ought to be planted in February if they are to bloom in October, when summer flowers are not to be had. A bouquet of Chrysanthemums will keep in flower for weeks if placed in wet sand.

I dare say you have seen wreaths of flowers called 'immortelles,' which some people put on the graves of their dead. On the Continent these are much more used than in England. The flowers of which they are made belong to the

Composite family, and do not wither for years, because each leaf contains a great quantity of flint, which is a mineral. A curious little flower called the 'Edelweiss' (*Gnaphalium Leontopodium*), which grows high up on mountains that are covered with snow, where no other flower can live, belongs to this family.

FIG. 87.

Chinese Chrysanthemum (*Chrysanthemum sinense*).

Before I finish my lecture I should like to show you this Sunflower that has been divided down the middle, that you may see how very thick that part of the stem becomes, called the *receptacle*, upon which all the ray-flowers and perfect flowers grow, and which holds all the food for these thousands of flowers to feed upon.

The coloured leaves of a flower, you remember, take in oxygen gas, which has the power of changing the starch into sugar, because neither an animal nor a plant can live upon starch. Flowers require a great quantity of oxygen gas. Flowers in a ball-room, theatre, or any crowded place, filled with people and gas-lights, fade directly, because the gas-lights and the people use up all the oxygen gas. It is easy to know a Single flower from a Composite flower, because a *single* flower can only have a certain number of leaves, placed round the receptacle. The calyx and corolla of an exogenous plant will each be made of four or five leaves, and if the flower has a great many stamens, say twenty, they will not be placed in one large circle, but in circles of five or ten each. You must examine a wild Rose, which is an exogen, and a perfect single flower. If you take an endogen, say an Orchid, you will find that the calyx and corolla have each three leaves. Orchids have three stamens, but only one, you remember, grows up to be perfect. An endogen can have six leaves in a circle, but not four or five.

Things taken to the Lecture.

Sunflowers, cultivated and uncultivated, Daisy, Chrysanthemums, Preparations on cards, Dahlia (picture).

THIRTEENTH LECTURE.

First Part.—On poisonous plants which furnish important foods and medicine, also flowers that become gayer and much altered by cultivation.

Second Part.—On a large family of plants called 'Cruciferæ,' which do not possess one poisonous member, grow in every quarter of the world, and contain green vegetables that are much altered and improved by cultivation and prevent the terrible disease called scurvy.

You will learn to-day, how much suffering, disease, and death have been prevented by a knowledge of the nature of plants, and how important it is that all sailors, emigrants, and all people who travel in foreign and unknown lands should be able to discover to what family a plant belongs. When a botanist examines a flower, he can tell at once the name of the family to which it belongs—not by its colour, shape, or scent, but by noticing how the stamens and pistils are placed inside the cup and corolla. He can also tell whether the plant from which the flower grew was poisonous or good to eat, because botanists know the good or bad substances that each family possesses, and whether these substances are to be found in the root, stem, leaves, or fruit.

You learnt at the last lecture that all the flowers of the Composite family have five stamens, whose pollen-cases, or anthers, are all joined fast together and form a tube through which the pistil rises when it is ripe. By this alone the whole family can be recognised. Every member of the Composite family also contains a white milky substance which is not poisonous, but has a bitter taste, and makes those who take it feel sleepy. I must mention a curious and important fact, which is, that the part of a plant where starch is stored up ready for the young plant to feed on is often quite free from the poison that is found in the roots, stem, leaves, and fruit. The Carrot and Parsnip, for instance, belong to a poisonous family called the Umbelliferæ. These two plants only live two years (biennials). The first year they have only green leaves, without flowers, which work hard and store up food for the next

year in the taproot, that does not suck up water, &c. The flowers, which then appear, feed upon this stored-up starch, which they turn into sugar; the seeds are formed, and then the plant dies completely away. It would not do for plants to store up sugar, as it would ferment, but starch will keep for hundreds of years. We only allow the Carrot and Parsnip to live one summer, and eat the food stored up in the taproot. Roots that only suck up water are often the most dangerous parts of a poisonous plant.

A whole family of plants may sometimes be known by having a certain shaped leaf. The Buttercup or Crowfoot family (Latin name, *Ranunculaceæ*) all contain a poison. The Ranunculus (or common Buttercup), as you will see by fig. 88, has leaves shaped like a crow's foot. This rule does not always hold good. All the flowers of this family are perfect and complete, have calyx, corolla, stamens, and pistil. All these organs stand quite separate round the stem, or receptacle. None of these organs grow fast together at the top, bottom, or any point. I will take this buttercup to pieces. First, I will pull off each leaf of the calyx. You see they come out quite free and perfect. Now we will pull off each leaf of the corolla. They, too, are perfect and separate. Now we come to the stamens that look like tiny yellow threads. Though they are so numerous, I could pull each of them off the stem separately if they were not so small. Now we come to a cluster of curious little green balls in the centre. Each of these little balls is a pistil, or fruit, and contains a little seed. If you examine one of these little pistils with your glass, you will find that the point at the top is curved like a little horn. This horn is the top of the pistil called the stigma, through which the pollen always passes to get down to the seeds inside. We shall find that all these little pistils, like the other organs, are free, and will come off separately. Though you will find that the flowers of this family have such very different shapes, you can always tell a member of it if you examine a flower and discover a great many stamens which

FIG. 88.

Buttercup.

are all separate one from the other, and also quite detached from the pistils, corolla, or calyx.

You would never dream that this curious flower called Monkshood (fig. 89) belonged to the same family as this little Buttercup. The five leaves of the corolla in the Monkshood stand up, so as always to protect the pistils and stamens, in the shape of a hood, such as monks wear to cover and protect their heads; but the leaves in the corolla of the Buttercup are all the same shape, lying flat when the day is fine, but when rain is coming the leaves curl in, so as to cover and protect the stamens and pistils from the wet.

FIG. 89.

Monkshood.

The Monkshood is a handsome plant, and its flowers look well growing in hedges, where they had better remain, as even the smell is injurious to some people. If a leaf were to touch a part of the hand where the skin is torn, the limbs would become painful and a stupor come on. The poison, called *Aconite*, is found in the leaves, stem, flowers, and fruit, but the greatest quantity lies in the root, which unfortunately resembles horse-radish (*Cruciferæ*), and is sometimes sold for it in mistake, and whole families have been poisoned. Doctors find aconite a useful medicine, but no one should take it unless it has been ordered by a medical man. The Buttercups, which make our green fields look so gay, are not without this poison. People have an idea that cows eat them, and that they make the butter and milk rich, but this is a great mistake. Cows are too sensible to touch

them. None of the Buttercup family furnish food for either man or beast. 'Wolfsbane' is another name for Monkshood, because hunters used to dip their arrows in the juice when they hunted wolves. A gardener at Scarborough told me he once saw a child nearly poisoned by eating some part of this plant. The father found the poor little girl lying fast asleep, and carried her into the house. Nothing would rouse her from this sleep, not even a band of musicians who came on purpose and played as loud as they could. At last the father, in despair, took her and placed her across his knees with her face down, when she directly began to vomit, and it was soon discovered that she had eaten the poisonous plant. Now, whenever you see anyone who has eaten what you think is poison, make them sick as quickly as possible, by giving them mustard and water, which is the best thing.

Gardeners prize the Buttercup family very much because they bear flowers whose colours can be very much improved by cultivation. Anemones, for instance, change greatly by being planted in a rich soil. Hepaticas are very like Anemones in appearance, but not like them in their manner of living, as they grow best in a cottage garden, where they have to take care of themselves and grow strong by plenty of fresh air and eating simple food. For this reason they are called 'the poor man's flower.' Clematis, called Traveller's Joy, or Virgin's Bower, is a plant which grows in hedges and against walls. Hellebore, Marsh Marigold, Christmas Rose, Larkspur, Columbine, Peonies, are gay flowers which have originally been brought from abroad. Those which are natives of Great Britain are smaller and less showy. There is a peculiarity about the calyx of the Buttercup family which I must not forget to mention. Directly the blossom opens the calyx falls off; it does not remain to protect the little pistils until they grow ripe and strong, as you remember the calyx does in the Geranium family. The common Buttercup has always been a great favourite among artists. Beautiful designs and patterns have been made from this plant. You will often see the leaf and flower carved in stonework in churches. I will show you some of these designs in this book which you have seen before.[1]

[1] *Plants: their Natural and Ornamental Treatment.* By F. E. Hulme.

I am now going to give you a short history of a family called the *Solanaceæ*, that contains several very strong poisons, the Deadly Nightshade, the Henbane, the Thornapple, and the Winter Cherry. These bear very showy flowers and fruit. The Potato, Bitter-sweet, Tomato, Tobacco, and Cayenne Pepper plant bear small berries, either green or red. The Bitter-sweet is a pretty creeping plant. The Cayenne Pepper plant, with its pretty foliage and bright red berries, is often cultivated as an ornamental plant for decorating a drawing-room or a dinner-table. I should not like to have it in a house where there are children.

FIG. 90.

All the last-named plants bear very pretty flowers, and are nearly exactly alike in form, except the Tobacco flower, which has a long funnel-shaped corolla. A brother-in-law of mine once made a bouquet for his button-hole of fern leaves, with a bunch of Potato flowers in the centre, like the bouquet

in the picture. He then went to his gardener and asked him to tell him the name of the flower. After looking at it for some time the gardener declared he did not know it. He

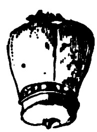
FIG. 91.

Henbane.

FIG. 92.

Flower.

FIG. 93.



Fruit.

next called upon a lady, who soon noticed and admired the bouquet, and begged to have the name of the flower, because she said she felt sure they had none like it either in the

garden or the conservatory. My brother was greatly pleased to see the lady's surprise when she heard its name. You will find that there are many plants besides the potato which bear pretty flowers and beautiful leaves, fit to grace a drawing-room, that people pass by and never think of noticing because they are 'common,' or perhaps only grow in a kitchen garden.

The fruit of the Henbane contains a deadly poison, and is rather like a Filbert. Hens and poultry are killed by eating this fruit. It is a strange fact that horses, goats, and pigs can eat it with safety. The Deadly Nightshade (*Atropa Belladonna*) has a very tempting fruit which resembles a black cherry, and has rather a sweet taste. A substance called *atropine* is taken out of this plant. Silly and ignorant women put this poison into their eyes to make the pupil, or window of the eye through which the light passes, grow larger than it would naturally do. Alas! when they grow old, the windows become injured and will not open to let in the light as they would have done if they had been let alone.

The working people in Ireland, about twenty years ago, lived almost entirely on a vegetable that belongs to the *Solanaceæ* family, and we, in England, rich and poor, eat it every day at our dinners. It is our old friend the Potato. Now, the Potato proves that what I told you is true, about our being able to eat the starch that is stored up in a poisonous plant when it is cooked. The Potato is not a root at all, but a branch or stem covered with little buds, and filled with starch prepared ready for the buds to feed on next spring. This branch, instead of spreading out, grows round like a ball, and lives under ground, where, of course, it cannot send out any leaves. Fortunately, the Potato plant has a great many leaves on the branches that live above ground, and very hard they must work to prepare all the food that is stored up in the Potato, or under-ground stem, and to feed the flowers, fruit, and seed that live in the open air. You will be able to see what the branches, leaves, and fruit of the Potato are like by looking at the picture of the Cayenne Pepper plant, only that the fruit or berries of the Potato are green instead of red. Sir Walter Raleigh brought the first Potato to Ireland, in 1580, from the West Indies.

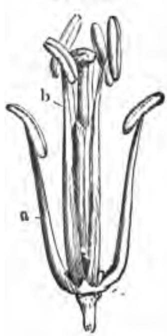
I have still one more important member of this family to mention, as the leaves of this plant furnish the article called 'tobacco.' It is said that twenty-five million pounds of it are brought every year to England. Sir Walter Raleigh was the first man who introduced the habit of smoking into England. Until his time tobacco was considered a weed.

Those who first saw Sir Walter Raleigh use this weed thought he must be on fire when they saw smoke coming out of his mouth, and ran to fetch a bucket of water, which they threw over him. The poison in tobacco is called *nicotine*, and is very powerful and sinks into the pipes and discolours them. Children have been killed by sucking the nicotine out of an old pipe. It was only the other day that I read an account of a child who was killed in this way.

I am sure you must be anxious to be told how you may recognise any plant that belongs to this family by examining the flower. The corolla has five leaves, and there are five stamens. The five stamens are always fastened to that part of the corolla where the leaves that form the corolla are joined together. Flowers of a different family have also five leaves and five stamens, but the stamens are not fastened to the corolla in the part of the corolla I have mentioned.

You shall now hear about a family of plants which are of the greatest importance to man, live in all temperate parts of the world, and are none of them poisonous. They are called *Cruciferæ*, which means 'cross-bearing.' This name is given because the four leaves of the corolla grow in two pairs, two at the top and two at the bottom, and form a cross.

FIG. 94.



We will open the flower, and we shall find that the stamens are also placed in pairs (fig. 94). Two long stamens stand on one side of the pistil and two on the opposite side, and then two short ones opposite each other lower down, making another shaped cross called 'Maltese.' The Cruciferæ are the only known family that has its stamens arranged in this way—two short and four long. This

family is a great favourite with gardeners, for not only can they make the flowers grow double—that means, change the stamens and pistils into leaves by rich food—but they can make the stem, branches, and buds grow fat and fleshy, so that we can eat them when they are cooked—the Cauliflower, for instance. There are a great many different kinds of Cabbages called Seakale, Scotch Kale, Savoys, Cauliflower, Broccoli, and Brussels Sprouts. Every kind of Cabbage has sprung originally from a very poor plant. Seacolewort, or *Brassica oleracea*, which bears a few leaves and small blossoms, grows wild on the cliffs near the shores of the South of England. Turnips, Radishes, Mustard and Cress, Horse Radish, Watercresses, and Pepper-root are members of the Cruciferæ.

I am sure you will all remember the account I gave, in my lectures on the Laws of Health, of that terrible complaint called scurvy, which used to kill so many of our poor sailors who were fed on nothing but salt meat, bad water, and no fresh vegetables which contain a mineral called 'potass,' which prevents scurvy. Captain Anson, who went round the world and was absent nine months, lost 620 men from scurvy. During this time these poor men explored countries which were full of fruit and vegetables that would have saved their lives, but unfortunately the doctor on board did not understand the nature of plants, and therefore was afraid to let any of the sailors eat food that would have kept off this fatal disease. Nearly at the same time Captain Cook sailed round the world and was absent three years. Whenever he came near land he sent his men on shore to gather all the fruit and green stuff they could find, and as he was a good botanist he allowed the sailors to eat what he knew would not poison them. The consequence was that all his men, except four, returned home in perfect health.

Wallflowers belong to the Cruciferæ. I recommend you *not* to try to rear them from seeds, but to go to the market in the spring and buy some young plants. Wallflowers and Stocks grow double and change their colours when placed in rich soil, but soon return to their single state if neglected. Stocks, I am sorry to say, soon lose their bright colours in

smoky towns, but Wallflowers are as strong as they are sweet, and put up with a great deal of smoke and dirt. This pic-

Fig. 95.

Wallflower.

Fig. 96.

Stock.

ture of a single Stock shows you how the leaves of the corolla form a cross as they do in the Wallflower.

FOURTEENTH LECTURE.

ON FRUITS.

DESCRIPTION OF THE FOLLOWING FRUITS.

Berries.—Gooseberries, Currants, Grapes.
Stone Fruits.—Plums, Peaches, Cherries, Raspberries, Blackberries.
Hard Fruits.—Nuts, Cocoa-nut.
Dry Fruits.—Wheat, Barley, &c., and all grain.

We all know that if plants did not bear fruits and seeds, men and animals would die, because they depend on them for their daily food. We now want to know of what use a fruit is to the plant. A fruit is a case, or box, made to protect the seed until it is ripe and ready to fall into the ground, where it will be covered over by earth, and so be safely preserved from birds and animals that feed on seeds. The fruit, or seed-box, like every organ of a plant, is only an altered leaf, folded into a shape to suit the form of the seed or seeds it contains. Some fruits or seed-boxes are so very strongly made that it is necessary to break them open with a hatchet in order to take out the seed, the Cocoa-nut for instance. When we think of fruit, we generally fancy something that we can eat, but it is only the seed inside the fruit of the Cocoa-nut that can be eaten.

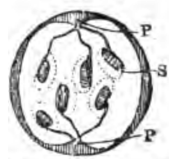
I wish you to look at the fruits and models of fruits and berries which I have brought and intend to explain to-day, the Cocoa-nut, Grapes, Gooseberries, Currants, Oranges, Plums, Cherries, Blackberries, Raspberries, Strawberries, Figs. You will not find it difficult to understand how a fruit is made by a folded leaf, if you first clearly understand how a leaf is made, and can believe that a leaf has not only what you see, an upper skin and an under skin covered with pores through which it perspires, but that between these two skins there are a great many rows of cells placed one above another, filled with the same living matter that lies between the two skins of a human hand. Some leaves have the shape of a hand. I must ask you to picture a leaf to have also the thickness of

a hand, because it looks nearly as thick when seen through a microscope.

I will first try to explain a Grape, which is a soft seed-box, called a berry. I will send you these grapes to examine with a hand-glass, that have been divided down the middle, so that you can see the seeds, and how they lie in the middle of a juicy substance. Then look at the outside of the Grape, and you will find it is covered with a thin green skin, a piece of which is turned up for you to see. This green skin is the upper skin of the leaf. The soft juicy portion round the seeds is formed from those rows of cells that lie between the two skins; but where, you will say, is the under skin? You cannot see it, because that skin, like the cells, has also been turned into a soft juice. I must now ask you to notice the beautiful shape into which the leaf has been folded. A Grape is a perfect oval. Look also at the soft bloom that covers it. This bloom is not only beautiful, but useful, as it is made of a waxy substance that prevents any wet or damp from entering the soft box that might injure the seeds. Botanists have a great many names for a fruit, or seed-box, such as a pistil, ovary, carpel. I think *carpel*, which means a little fruit, is the best, and I shall therefore often use it.

A Gooseberry and a Currant are made like a Grape. I have a model of a Gooseberry (fig. 97), which shows you the upper skin of the leaf, the middle cells, and how each seed has a thread or stalk which fastens it to the soft substance under the upper skin.

FIG. 97.



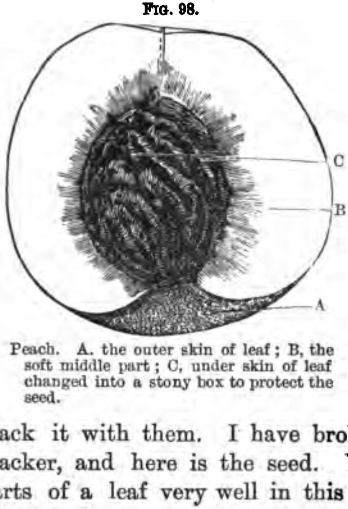
Gooseberry. S, seed. The part of the fruit to which the seeds are fastened by a thread or stalk is always called the *placenta*, to be seen in the Gooseberry at P, P.

An Orange looks as if it was only one fruit, but it is really made of a great many fruits or carpels, which are all bound together and covered by a thick yellow skin. Here is an Orange that has been opened. You see I have separated all these carpels. Each of them contains some seeds. I dare say you have often divided an Orange in this way, so as to give a piece to a friend, but you gave really a part of a fruit or carpel. I think you will see that each division of an Orange looks like a folded leaf. The thick yellow skin

contains an oil that keeps out any damp and enables us to preserve Oranges for so long a time.

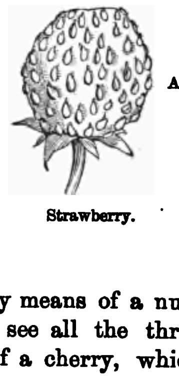
We will now try to understand how stone-fruits are made of one folded leaf. Here is a Plum. We will first take off its cover, or outer skin, which is the upper skin of the leaf that has changed its colour from green to purple. Now we come to a soft green substance which is the middle *fleshy* part of the leaf, as it is called. Now again, you will ask, where is the under skin of the leaf? This time I can show it to you because it has been changed into a substance as hard as stone to cover and protect the seed. This little stone box is so hard that we shall very likely break our teeth if we try to

FIG. 98.



Peach. A. the outer skin of leaf; B, the soft middle part; C, under skin of leaf changed into a stony box to protect the seed.

FIG. 99.



Strawberry.

crack it with them. I have broken it by means of a nutcracker, and here is the seed. You can see all the three parts of a leaf very well in this model of a cherry, which takes to pieces, and which shows you not only the seed inside the stone, but the little plant or germ lying inside the seed. All stone fruits are made exactly like the Plum, Cherry, or Peach (fig. 98).

It sometimes happens that a great many very little stone fruits grow together on a stem, or receptacle, and look like one fruit, just as a great many flowers, in the Composite family, grow on the receptacle and look like one flower. When we eat a Blackberry, Strawberry, or Raspberry, we

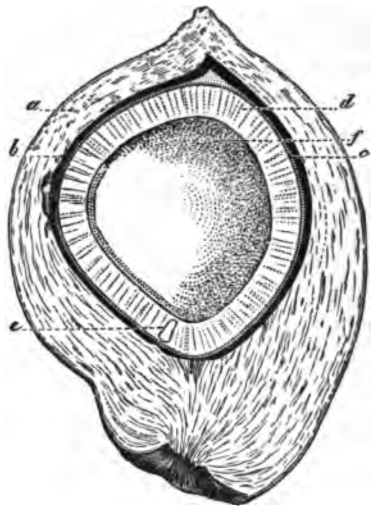
eat a cluster of stone fruits. The stones in these fruits are so small that we scarcely notice them. I have some ripe Blackberries fastened to white cards, so that you can look at them through a hand-glass and examine the little balls for yourselves. The receptacle of a Raspberry on which the little balls are placed, has a pointed shape, which you must remember, as you are always obliged to pull the Raspberry off this point before you can eat it. A Strawberry is a soft juicy ball, the outside of which is covered with a great many little hard dots. If you could see these little dots through a microscope, you would find that they are little dried fruits which have become separated from one another, because the receptacle, on which they were clustered together when young, gradually swelled out into a ball and divided them. This model of a Strawberry is divided into halves, so that you can see the swollen stem inside. This picture shows how the little dots or dried fruits like a grain of corn, or fruits of the Buttercups, cover the ball or swollen receptacle.

A Fig is a collection of tiny stone fruits, that are completely bound and covered up by a juicy stem. If you examine the outside of either a green or dried fig, you will find that it is quite smooth, but cut it open and you will discover that the centre is quite filled with the same hard little dots that lie on the outside of the Strawberry. Blackberries, Strawberries, and Raspberries ought not to be called berries, because a true berry is a fruit or seed-box, that is made of a leaf, every part of which has become soft and juicy.

I now come to hard fruits, such as the common nut I hold in my hand. This seed-box or fruit is made of a leaf, every part of which has become hard and dry. The Cocoa-nut shell is a much stronger seed-box. I have brought a Cocoa-nut to show you. The hairy part (*a*) is made of the soft centre of the leaf; the hard stone (*b*), of the under side of the leaf; *c*, is the seed skin; *f*, the place where the milk is contained; *e*, is the germ. Cocoa-nut mats and ropes are made out of this hairy part. The Cocoa-nut is the fruit of a Palm-tree. The shell is made into many useful utensils by the natives of the countries where it grows. The seed is a very nutritious food when eaten fresh. We only see it in

a dried state. Cocoa-nut Palm-trees are found growing upon islands which have never before been visited by men. People have therefore wondered how they came there. The Cocoa-nut is so constructed that it can float in the sea a long time without being injured. No doubt some nuts have been washed on to the shores of these islands, sunk into the earth, where the shell has gradually rotted away, and let the seed fall out into the ground.

FIG. 100.



Cocoa-nut.

There are, it is said, no less than a thousand different Palm-trees. The large leaves of the Wax Palm in South America are used to cover the tops of houses instead of a thatch, and, owing to the wax they contain, they have been known to keep out the wet for twenty years. The centre ribs of the skeleton of these leaves are so strong that they are used as oars for rowing boats. Dr. Carpenter saw a Cabbage Palm growing in the island of St. Vincent that stood two hundred feet high. The Date Palm grows in Egypt, Arabia, and Persia. The working people, as I told you, in these countries almost live on the Date fruit. The ground stones serve as food for the

camels. It is a soft fruit, you see, and is often sold in a dried state in our English shops. The wood of some Palms takes a fine polish. Their stems are made into drums, and pipes that carry water, and some of them have wood almost as hard as iron, out of which weapons of war have sometimes been made. No less than three hundred and sixty different substances are obtained from Palms of various kinds, such as wine called 'arrack,' oil, salt, a kind of flour which is made into bread from the pith of the Sago Palm, and clothing of different kinds made from the fibres of the Cocoa-nut. No wonder Palms are said to be the princes of the vegetable kingdom. These glorious trees can live on the borders of a sandy desert, on the banks of rivers and sea-shores where rain seldom falls, but the air is filled with heavy dews. When you go to Kew Gardens you will see a large glass-house where a great many Palm-trees grow.

I have said that the Palm-tree is as important to people who live in dry countries as the Grasses are to us, which bear Wheat, Barley, Oats, and all kinds of grain that only grow in temperate climates. People generally suppose Wheat and all grain are seeds, but they are really little dried fruits. The seed lies inside a folded leaf that becomes quite dry and grows fast to the seed. Stories are told of wheat having been found perfectly good in mummies a thousand years old. We will examine the model of a grain of Corn (on page 6, fig. 4), as it shows us the three parts of the thin dry leaf that forms the fruit and protects the seed. The three edges of the three skins are turned down at C. This dried leaf seems a poor protection for a seed, but you must remember that there is a mineral called flint, or silex, in the leaves of all Grasses, that prevents water from entering them.

FIFTEENTH LECTURE.

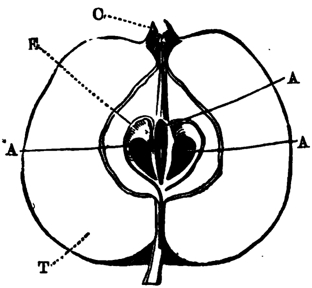
DESCRIPTION OF THE FOLLOWING FRUITS:—

AN APPLE, PEAR, CUCUMBER, VEGETABLE MARROW, GOURD, ACORN, PINE-APPLE, FIR-CONE.

THE fruits I am going to explain to-day are lying on the table before me. We have an Apple, Pear, Cucumber, Vegetable Marrow, Gourd, an Acorn, a Pine-apple, and a Fir-cone. You shall first learn all I can tell you about an Apple.

An Apple is not what it appears to be—one true fruit, made out of only one leaf. This is a fact that can be proved, because if you cut an Apple into two equal parts (fig. 101), you will find three little fruit-boxes or carpels (E) lying snugly in the centre of the Apple, with one dark seed, called a pip (A), in each of them. These little boxes are made of a hard bony substance, as you will know only too well if you have ever been so unfortunate as to get one into your throat when eating an Apple. Cooks carefully cut out this part, called the core, when they are making an apple-tart or pudding. Out of what, then, you will ask, is that thick white part of the Apple (T) made which we eat, and find so good when it is quite ripe? It is made out of the five calyx leaves that stand round and protect the three little carpels inside the Apple flower. When the coloured leaves have fallen off and the seeds are growing ripe, the calyx leaves grow thicker and thicker, until they quite bury the little true fruits or carpels in the centre of the Apple. You can just see the points of the calyx leaves at the top of the Apple (C). An Apple is a very strong fruit, and not easily blown off the tree, because it is fastened on to the

FIG. 101.



Half an Apple.

branch very firmly by the five bundles of woody fibre that spread out and form the skeleton of the leaf, fasten it to the stem, and then pass down the stem into the earth to become roots. These roots will work and send up water and mineral foods to the leaves, to enable them to make all the food that the fruit requires.

The shape of the Pear is different from that of an Apple, but its construction is exactly the same. Stone fruits, such as Peaches, Plums, &c., are not nearly so strong as an Apple, as they are only fastened to the branch by the one bundle of woody fibres that comes from the single leaf which makes the fruit or seed-box. The stone they contain is heavy, and while it is forming, the fruit requires a great deal of food, and the branch on which it grows should have a great many leaves. You must remember that the food is sent *down* the stem, therefore the leaves that grow on the young shoot *above* the fruit are those on which it will chiefly depend for its support. A great many ignorant gardeners are very fond of cutting off branches and removing the leaves. They sometimes take away the very branch that is of the greatest importance. A cold spring is very bad for fruit, because the earth becomes so cold that the roots cannot work and supply the leaves with water, &c. The cold also kills the pollen in the blossom. The young fruit then is starved, and grows small and weak. A high wind fortunately comes and blows off the weakest, so that the strong ones that are left feed on the food that would not have been enough had they all lived. As the wind cannot get into a greenhouse, gardeners have to remove the weak ones.

I dare say you will be as much surprised as I was to find that fruits which are so differently made, such as Apples, Pears, Peaches, Nectarines, Blackberries, Raspberries, Strawberries, Hips and Haws, are all members of the same family, called the *Rosaceæ*, or Rose family. Though their fruits are so different, their flowers are all made on the same plan—having five leaves in the calyx, and five in the corolla. Each of these leaves is placed separately on the stem, and not fastened to any other; but the stamens, which are numerous, do grow fast to the calyx. You must examine a wild Rose, and you

will find that this is the case. Buttercups are made very like Roses; the only difference is that the stamens in the Buttercup do not grow fast to the calyx, or any part of the flower. I mention this fact to show you how carefully a botanist must examine a flower to find out to what family it belongs. You will find that in every flower belonging to the Rose family there are a great many little carpels in the centre. These carpels in the Blackberry and Raspberry all grow into little stone fruits; but in the flower of the Plum, Peach, and Nectarine only one of these little carpels bears a seed and becomes a fruit. Every member of the Rose family contains the same substance, which is a poison called prussic acid.

It is only by carefully examining the flower, that we can discover to what family a plant belongs. We cannot gain this information from the fruit. For instance, Cucumbers, Vegetable Marrows, Melons, Gourds, Pumpkins, are fruits made like the Apple; but their flowers are quite different, and they therefore belong to another family, called the *Cucurbitaceæ*. These fruits are natives of the East and West Indies, Arabia, and Egypt, where they not only serve as foods, but make excellent utensils of different shapes used in the place of basins, jugs, spoons, bottles (the bottles are sometimes six feet long), &c. These utensils are called 'calabashes.' The fruit is divided, the inside is scooped out, water is then put into the hollow shells and changed several times until it has lost any bitter taste, and then they are ready for use. A large collection of these vessels can be seen at Kew; some of them will take a very fine polish, and have been made into little teapots, &c. (page 155).

There is a large family of plants called the Cup family (Latin name *Cupuliferæ*), because the calyx grows very hard, and forms a cup for the fruit to rest in. The fruit of the Oak rests in such a cup, and is called an Acorn. Here is the model we have so often seen of an Acorn (see page 5, fig. 1).

I have now come to the Pine-apple (fig. 103). I wish you to look and examine its shape, colour, and the beautiful green leaves that grow through the top of the fruit. Pine-apples are found growing wild in some parts of Africa. They can be bought in the West Indies for sixpence each. This one cost

two pounds, as it is winter time, when they are very scarce, and difficult to rear. Though we cannot eat this Pine-apple, we can enjoy its delightful odour that fills the room. Like all plants that come from hot dry countries, where rain only falls once or twice in a year, they have either a great deal of food stored up in bulbs, like the Hyacinth, Tulip, Lily, or else have very thick leaves, like the American Aloe. I have brought a Hyacinth (fig. 102), because it has long grass-like leaves, just like those of the Pine-apple, and because one botanist (De Candolle) considers that the Pine-apple, Hyacinth, Tulip, and Lily are members of the same family. In

FIG. 102.

Hyacinth.

FIG. 103.

Pine-apple. C, calyx; A, crown.

order to make you understand how the fruit of the Pine-apple is made, I must ask you to look at this cluster of flowers that grow round the stem of the Hyacinth; for the Pine-apple, though it looks one fruit, is really a large cluster of fruits.

You must notice that the outside of the Pine-apple is covered with flattened spaces which fit close to each other. Each of these spaces contains a flower, and these flowers, with the stem, have all grown sweet and fleshy. You can see a little yellow leaf (C) in the centre of each space, which is the calyx.

You will naturally ask what that bunch of leaves (A) can be that is growing out of the top of the Pine-apple, as the Hyacinth has none of these leaves. The bud at the top of the stem in the Pine-apple happens to be a leaf-bud, and therefore throws out leaves. This cluster is called the crown, and gardeners often take it off, and plant it as they would do a cutting. You will understand that when the bud at the top of a stem is a *flower*-bud, as it is in the Hyacinth, a flower comes out there, and the stem does not grow any more.

Pine-apple seeds are sown when a gardener wishes to have a different sort or variety, but when he wants exactly the same kind of Pine, he plants the crown.

Perhaps you have noticed that none of the fruits or seed-boxes I have shown you, either to-day or at the last lecture, opened or divided in any part to let the seeds fall out. The seeds could therefore only escape when the boxes had become rotten and fallen to pieces. Even the hard Cocoa-nut shell soon decays in the warm damp earth. Fruits that have no opening have a Latin name that means 'not dividing' (*indehiscent*). There are also a great many fruits or seed-boxes which open in one or more places directly the seeds are ripe. These fruits have a Latin name that means 'dividing' or 'opening' (*dehiscent*). A pea-pod is a seed-box that opens on two sides.

You can see on this card, that has the pressed leaves I showed you, a Beech-nut, which is a fruit that opens in four places. As it is ripe and just open, you can see the two little seeds lying at the bottom of it. The fruit of the cotton plant has a great many divisions. When it opens, the cotton that grows on the outer skin of the ripe seeds swells to a great size, and looks like a soft ball of cotton-wool.[1]

Now I come to the last and most simply-made fruit, called a *cone*, that belongs to the class of plants that bear flowers and seeds. A cone is a cluster of fruits or carpels. Each of these little hard leaves is a pistil or carpel, which covers either one or two seeds. These hard leaves lie so close, one over another, that the seeds are perfectly protected from the cold and wet (fig. 104). Directly the seed is ripe, the leaves all sepa-

[1] *Kew Museum*, p. 162.

rate, so as to allow them to escape. As each seed is provided

FIG. 104.

Staminiferous and Pistilline Cones.

with a little wing, it is easily carried away by the wind.

All Fir-trees bear cones and belong to the family of the *Coniferæ.* The following are its principal members:—The Yew, whose leaves are very poisonous to men and animals; the Cedar of Lebanon, the Silver Fir, the Spruce Fir, the Scotch Pine, and the Larch. Some Fir-trees are diœcious, and others have a staminiferous cone, and a pistilline one. These two cones grow on the same branch at a short distance from each other (fig. 104, A, B). The seeds, of course, always grow in the pistilline cone. The seeds have all fallen out of the cone (B) in the picture, as each leaf has opened out.

No trees are of greater importance to man, for they grow not only in every quarter of the globe, but in cold countries and up the sides of high mountains where no other trees can live. As nearly all Fir-trees are evergreens, they make the bleakest mountains, whose tops are covered with perpetual snow, look beautiful even in the depths of winter. Their leaves, you see, are very narrow and long (L). No doubt, in this shape, they can bear the cold winds better than if they were spread out like other leaves. There is a great deal of turpentine in all Fir-trees. Doctors consider that turpentine purifies the air; they therefore send delicate people to places where there are Pine forests, that they may recover their health.

As turpentine is so healthy, it is a great pity that we do not have our sitting-rooms and bed-room floors rubbed with turpentine and bees-wax, and only a small piece of carpet placed in the centre. Instead of this, we have large pieces of carpet that go into every corner, and soon become filled with dust and even with the germs of disease.

The Pine, or Scotch Fir, is a native of Great Britain. Pieces of this tree are found buried in peat bogs, which must be thousands of years old. From this fact it is supposed that in very early times the hills of Scotland, England, and Ireland were covered with large Pine forests. Most turpentine is found in the roots. The Scotch make torch-lights of the roots by splitting them up into pieces. This wood, when ripe, has a beautiful red colour, and is almost as hard and durable as Oak. A great deal of furniture is made of this wood. The Swiss people are very clever at turning wood, and make

clocks, boxes, and every kind of wooden ornament from Pine wood.

In very thick Pine forests, where the trees stand so close together that the sun cannot get to them, the stems grow very tall and straight, without any branches, because only the top leaf-buds get the sunlight. The stems of these tall trees are used as masts for ships.

Before I conclude this long lecture I must say something about the Larch, because it is the most graceful, durable, and useful of all Fir-trees. At Dunkeld, in Scotland, the Duke of Athole has large woods of nothing but Larch. The wood is a dark red colour, and furniture made of it is equal in beauty to that made of the most costly wood. Artists can paint upon it. A great many of Raffaelle's pictures are said to have been painted on boards of Larch. Splendid specimens of Larch, Pine, and all woods are to be seen at Kew Gardens (page 157). I hope you will go into some wood next spring where young Larches are growing. The shape of the whole tree is very beautiful, with its bright green feathery branches that look like long waving plumes. If a Larch is planted in very poor soil where only Heath will grow, the dead leaves and the drippings from the trees make the earth so rich that in a few years a grass grows which is excellent food for cattle and sheep. I must not forget to mention that it is most difficult to set this wood on fire, and it is therefore very valuable in building ships and houses.

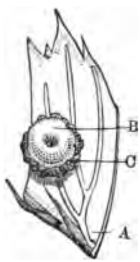
I hope the little I have told you will make you study trees. We really are not able to select good furniture unless we understand their nature. It is said that the whole shape of a tree in leaf resembles the form of its fruit. This is certainly the case in some Fir trees, as the cone goes up to a point like a pyramid, and so does the tree. Gardeners often protect young plants in the winter by covering them over with old Fir trees.

SIXTEENTH LECTURE.

ON FLOWERLESS PLANTS, AND HOW A KNOWLEDGE OF PLANTS HAS HELPED TO CIVILISE MANKIND.

BEFORE I begin this Lecture, I had better recall to your minds that the seeds of flowering plants contain a good deal of food for the little germ or plant inside to feed upon, until its leaves have grown out of the ground, and can prepare all the food it requires. Ferns, Mosses, Fungi, Lichens, Seaweeds (Latin name *Algæ*) have no flowers, fruit, or seeds, like flowering plants, but bear little germs, called *spores*, that are able to feed themselves directly they fall from their parent plant into either earth, air, or water, and grow up to be like their parents. I have brought a Fern to show you. The spores or seeds are all ripe, and you will find that they are held in beautiful little

FIG. 105.



A, part of a Fern leaf; B, spore-case; C, elastic ring.

FIG. 106.

A Fern leaf with clusters of seed-boxes or spore-cases; these clusters are called *sori*.

boxes or spore-cases. Each spore-case is surrounded by an elastic ring. Directly the spores are ripe, the elastic ring grows so tight that it breaks, and out fall the spores, that look like yellow powder, as you can see by what has fallen from the Fern into this white paper. You shall examine some Fern leaves that have been gummed on to these cards, with a magnifying glass, and you will find that they are covered with the little spore-cases that I have just described.

Ferns do not bear buds. If you sow Fern seeds in a flower-pot, you will find that little green balls appear outside the earth, which gradually untwist and open out into a Fern branch, which is called a *frond*. If fronds be cut when green, and put into the ground, they decay away, and make the soil much richer. Ferns chopped up in this way improve potato crops, if put under their roots. The seed-boxes are of dif-

FIG. 107.

Urn Moss.

ferent shapes and colours. The Silver Fern has white seed-cases, which make the under side of the leaf look like silver. This I have brought is a Golden Fern, because its seed-boxes are yellow, and make the under side of the leaf look like gold. The seed-cases come on the edge of some Fern leaves, and are nearly hidden, because they lie between the two skins of the leaf. This is the case with the common Bracken.

There are thousands of different kinds of Ferns. In Great Britain alone there are at least fifty different kinds or species. I am sorry that these elegant and interesting plants do not bear smoke and dirt. At the end of my Lecture a little pamphlet will be given to each of you, in which you will find directions how you may have a small fern-case for about a shilling (page 143).

Now, I must tell you something about Mosses, as no plants are more wonderful and interesting. Even now, in the winter, if you take a walk in a wood, you will find old trunks of trees and hard stones looking lovely, covered with fresh

FIG. 108.

1, model of seed-box of Urn Moss; 2, urn divided, showing the ring of teeth (B); 3, calyptra; 4, lid under calyptra; 5, inside of urn, showing a ring of teeth (B) which cover the seeds like a lid, and rise up when they are ripe. A, urn; C, calyptra; D, second lid.

green Moss, and surrounded with Ivy. Nature takes great pains to cover up and conceal all that is unpleasant to the eye. A Moss, like an Orchid, can live entirely on what it finds in the air. If this were not the case, how could it live on a hard bare stone?

I found the Moss which I hold in my hand growing on the top of a wall near Harrogate. My eye fell on something that had a lovely orange colour, and I soon discovered it to be my favourite Urn Moss.

The seed-box, called a *capsule*, of this Moss, is so wonder-

fully made, that I bought this beautiful model of one at Paris last autumn.

The bottom part of the case, where the seeds are kept (A), has a shape like an urn. The opening at the top of the box is covered by no less than two or three lids. I will remove them. The first (C) is called a little hood or lid (*calyptra*); the second lid (D), which lies under the little hood or lid, is pointed; now we come to a ring of teeth (B) that protects the opening. Directly the seeds are ripe, the bottom part of the box, called the *urn*, rises as if by a spring, and pushes off all the lids, one after another. The case is then gently turned, as if by an invisible hand, so that the seeds are poured out on to the ground, or are carried away by the wind, until they settle on stone walls, trunks of trees, or bare rocks, sometimes in the middle of the sea.

Though the little Urn Moss is so small and humble a plant, that its beauties can only be seen by a magnifying glass, its seed-box, which I have just described, is a perfectly beautiful object, because it has all the qualities that make perfection and beauty, namely, form, colour, proportion, symmetry, strength, use, and design. Directly you look at this box, your eye is pleased, because the colours all blend and suit each other. The form delights you, because the straight lines of the box make you notice the curved lines of the pointed lid. The whole box is made in proportion, because the lid or upper part is just the right size, not too little or too big. If it had been too big, you would have felt troubled as you do when you look at a deformed person, who has a large head and a very small body. The box is symmetrical, because I could divide it down the middle, and prove to you that both halves are exactly alike. This is what symmetrical means. It is very strong, because the heaviest animal or man can tread upon it without breaking or even crushing it. The box is useful and perfectly designed, because the seeds it is made to protect cannot be injured, and directly they become ripe, they are set free by a wonderful contrivance that removes the lids.

I dare say you have heard of a celebrated African traveller, called Mungo Park. Ninety-two years ago he sailed from

Portsmouth for Africa, determined to discover the River Niger. Every boy should read his wonderful adventures. On one occasion he had to swim over the Gambia, which was full of crocodiles and river-horses. After many narrow escapes from dying of thirst, or being killed by savage men or wild beasts, he found the long-sought river, and was making his way home, when he was attacked by robbers in a forest, five hundred miles away from any station or town. They were not satisfied with treating him most inhumanely, but left him without a rag to cover his body. This, in his weakened state, and after all he had gone through, was more than he could bear, and he laid himself down to die. As he was lying, his eye rested on a beautiful little Urn Moss, and though so wretched, he could not help noticing its exquisite colours and its beautiful shape. He soon began to think that if the Almighty could bestow so much care on a plant so small, He would care for him. These thoughts roused him, and he got up, and was soon delivered from his miserable fate. Soon after this adventure, he returned to his native country.

The stems and leaves of Mosses (Latin name *Musci*) have the power of holding a great quantity of water, like a sponge, and even when apparently dead will come to life again, if they can get water. They never become mouldy, like other plants, but make the earth and water in which they grow sweet and pure. For these reasons I told you to put some dry or fresh Moss over the pieces of pottery or stone, called 'drainage,' in your flower-pots, and then place the earth and sand over the Moss. When you water your flowers, the Moss will suck up a good deal of the water, prevent the earth from running out of the hole at the bottom of the pot, and keep the earth sweet and moist. All plants except Mosses become bad and unpleasant while they are dying, but a Moss continues wholesome even then, and when quite dead its little frame turns into a black substance called Peat, which burns like coal. The Irish and Welsh people use peat as we use coal. The smoke that comes from a peat fire is said to purify the air.

I dare say you have heard of the peat bogs of Ireland. These peat bogs have been made by large masses of Moss, which grew in deep ponds and turned into peat, which floats

on the top of the water or bogs. Peat bogs are often very dangerous places, because, though they look firm, directly a man treads upon them, he sinks in and is buried alive. It is only a few months since I heard of a young lady who went out alone sketching, and got into a peat bog, where she nearly lost her life. Chat Moss, near Manchester, over which the first railway was made, was once a bog. Gardeners mix peat with the earth, as it nourishes plants in the same way that manure or dead leaves do. Heaths, Azaleas, and Rhododendrons cannot live without it.

Fungi are very important plants to man. Some of them are poisonous, and some wholesome. Those that grow to a large size are Mushrooms, which you all know. The history of the poisonous ones, both great and small, ought to be known to every gardener. The size of some of them is so small that they can only be seen through a very powerful microscope, as you will believe when I tell you that twenty-four thousand Fungi, called Bacteria, will only cover a square inch. One of these little Fungi looks like a rod, and is called a *germ*. Though so small, they grow more rapidly than any other kind of plant. One little germ when it gets the food it likes will produce several hundreds in a minute. There are some that feed on bad air, such as is to be found in drains; others live in impure water. Directly any part of a plant becomes unhealthy, or is dying, there are plenty of these little invisible germs floating in the air, ready to pounce down upon it and eat it up. They do not attack healthy plants, but directly a plant grows at all weak or diseased, it has no chance of escaping from their clutches, unless it can be made healthy by good food and placed in good air.

Plants, like human beings, suffer from a great many diseases. The Potato disease arises from a fungus called *Peronospora infectans*. You will often hear gardeners and farmers say their plants or crops of corn are blighted. These blights, called Rust and Smut, are caused by different kinds of Fungi. These very little creatures even attack and destroy big trees. Fortunately there is a little bird called a woodpecker, that can get at them and stop their mischievous work. Take care you never kill a woodpecker. Ships and houses

built of wood are turned into ruins by a disease called dry-rot. Dry-rot is caused by a Fungus which works away in the middle of the wood, until it has turned the centre part into a soft powdery substance. The outside of the wood remains apparently all right, when suddenly the piece of wood breaks into pieces, and down comes the part of the ship or house to which it belonged. You see how very dangerous these little creatures are.

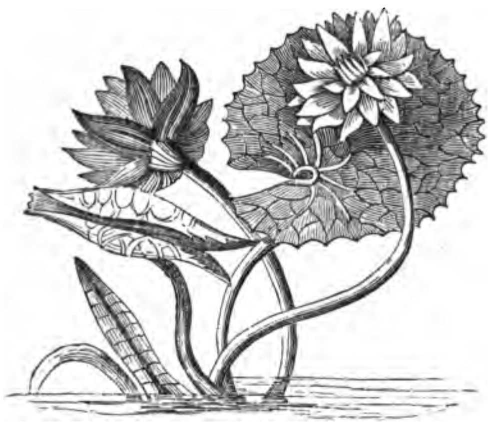
I have no time to say more than a few words about some very interesting plants called Lichens, which always live fastened to rocks and trees, and find their food in the air like Mosses. Lichens, unlike Fungi, live in very dry places where there is plenty of light. They live in the coldest countries, and even grow on glass and iron. The smallest only look like powder, the largest kinds have beautiful forms; their seed or spore-cases are called *asci*, and generally contain eight spores. The Lichens that are gelatinous are good to eat, such as the Iceland Moss. The Reindeer Moss that grows in Lapland is also a Lichen, not a Moss. Fortunately this Lichen can live and grow when buried deep under the snow. It is the only food the Reindeer has during seven months of the year. The poor Laplanders would starve, were it not for the Reindeer. Reindeer meat is their principal food during the winter. Explorers in the Arctic regions of North America have been kept alive for days by eating a Lichen they found growing upon rocks.

The last plants I have to name are Seaweeds (Latin name *Algæ*), which grow on the rocks at the seashore. This earth, which men have found so beautiful, must have looked terribly bare and wild before plants were created. Algæ, Fungi, Lichens, and Mosses were first sent to clothe the rocks, fill up wet places, and make a soil deep enough to support plants with roots, stems, and branches, such as Ferns and Fir-trees. These trees, after a time, became old and weak, and were blown down by the wind. Storms of rain swelled the mountain torrents into rivers, filled with mud, that flooded the earth and covered all these plants. After thousands of years and repeated storms, these masses of plants became buried deep in the earth, where heat and pressure turned their

little frames, which are made of carbon, into coal. People little think, when they sit by a hot blazing fire on a winter's night, that the heat and light they are enjoying has been stored up in the ground for millions of years. I hope you will go to our Leeds Museum, and look at some pieces of coal, on which are to be seen the impressions of ferns and stems of trees.

During the time that coal was being formed in the earth, we know that enormous animals lived that do not live now, because their large skeletons have been dug up where the coal comes from. One of these skeletons is hung up on the wall where the specimens of coal are kept.

FIG. 109.



Lotus Flower.

The world, you see, has gradually become more and more beautiful, so that when men were created they found plants growing, whose fruit and seeds furnished them with all the food they required, and flowers so large and qeautiful that even an infant's eye is attracted by their lovely colours. We shall find that, owing to a love and knowledge of plants, mankind became civilised. One of the earliest races whose ways of life are well known to us are the Egyptians, who lived in Egypt, on the banks of the river Nile. We learn their history by studying the wonderful buildings they have

left behind, and find by examining them that the Egyptians must have gained their ideas about the form and structure of these buildings from their love of flowers and knowledge of plants. In the very earliest times the Egyptians procured all their food, clothing, and the boats that carried them across the Nile, from two plants that grew on its banks, called the Lotus and the Papyrus. The Lotus bore a lovely white flower on its flower-stalk or stem, which went by the name of the 'Lily of the Nile,' though it was not really a Lily. The fruit (a berry) was much eaten by the natives, and, when dry and pounded, was made into bread. Wine was also made from the juice of the berry.

FIG. 110.

Papyrus Flower and Stem.

The boats I have mentioned were made of the leaves of the Papyrus. One of these boats hangs from the ceiling in the Endogen Museum at Kew. The only paper that was used for hundreds of years, called papyrus, was made by sticking together strips of the two green skins that lie under the outer bark of the stem. Clothing was made from the woody fibres in the stem, as we make linen out of the woody fibres from the stem of the flax plant. The Egyptians plaited these fibres into different geometrical patterns, such as squares, circles, angles, &c. I hope you will some day see a beautiful book called the 'Grammar of Art,' [1] in which these patterns are drawn. A large collection of clothing materials, mats, utensils, and ornaments is to be seen at the British Museum. The Egyptians were the first people who discovered the science of geometry, and measured their lands by means of squares, triangles, and circles. Perfect geometrical figures are to be found in the stems of a great many plants. For instance, no compass can draw a more perfect circle than is to be found in the hollow stem of a grass, nor a more perfect square than the stem of a Stinging Nettle; the Meadow-sweet is a pentagon (five sides), the Hop stem a

[1] Owen Jones.

hexagon (six sides), &c. The Papyrus, though it looks like a grass, is not one, but a sedge. Its stem is solid, and has three angles like a triangle.

FIG. 111.

A B C D E

Forms of different Stems. A, grass; B, stinging nettle; C, papyrus; D, meadow-sweet; E, hop.

Though the stem of the Papyrus looks very slender, it can stand upright in the midst of a rapid stream, because a corner cuts the water in two, sending some to the right and some to the left, just as the sharp corner of a buttress of a bridge divides the water and makes one half pass under one arch and the other half under the other arch.

The Egyptians understood colour, proportion, symmetry, utility, and design, because their buildings were made according to those principles of beauty and perfection. It is said they invented the art of making artificial flowers.

We know the Egyptians gained their designs for the stone pillars that supported their beautiful temples, where they worshipped, from the stems and flowers of their favourite plants, because the columns in the temple at Karnak represent the Papyrus plant. These columns are from forty to fifty feet high. The bottom is the root; the middle part, or shaft, as it is called, is the stalk; and the ornament at the top, or capital, is the full-blown flower (fig. 109).

The Lotus flower is also often used as the crowning ornament to a column.[1]

I am sorry to say that neither the Papyrus nor the Lotus now grows on the borders of the Nile.

We have gained a great deal of information about the habits and customs of the Egyptians, the dresses they wore, and the utensils they used, by the coloured pictures that they carved on the walls of their Temples and Pyramids.

Pyramids are the tombs in which the dead kings of Egypt were buried, and are the oldest and strongest buildings that have ever been built. The Pyramid in the picture is said to be five thousand years old, and there is a still older

[1] Kew Museum, p. 159.

one (Ouenephis) which, it is calculated, has stood for six thousand eight hundred years. The walls of some of the Egyptian buildings are not only covered with pictures, but with a curious writing, called Hieroglyphics, that no one could read.

In the time of Napoleon the First a French engineer, while making a fortification at the Rosetta mouth of the Nile, dug up a stone tablet cut in the triangular shape of the Papyrus stem, covered with writing in two languages—Greek and Egyptian. No one was able to understand the meaning of the Hieroglyphics until about fifty years ago a learned man,

Fig. 112.

The Great Sphinx and Pyramid. The Figure in the centre is the Sphinx.

Champollion, found out that the same information was given in the different inscriptions. As all the old Egyptian tombs and many of their buildings are covered with Hieroglyphics, we are learning daily more and more about the history of this wonderful people. The Rosetta Stone is now in the British Museum. I went to see it last summer, and was disappointed to find the stone so much broken that it had little resemblance to the triangular shape of the Papyrus stem. An Egyptian obelisk, called Cleopatra's Needle, has lately been brought from Alexandria, a town in Egypt, and placed on the banks

of the river Thames. It is very interesting because it is covered with the same kind of Hieroglyphics that are seen on the Rosetta Stone. It is also a beautiful object, as it has proportion, symmetry, design, and strength.

I wonder what the Egyptians who lived six thousand years ago would say if they could see so many of our buildings, furniture, and ornaments that have none of the qualities I have mentioned which make things beautiful; houses so miserably built that a high wind can blow them down; drain-pipes so badly laid that the houses are filled with bad gases that cause fevers, disease, and death, as Mr. Teal described to us all in Leeds last winter.[1] I am afraid we shall never grow wiser and better until children like yourselves are taught to study the works of nature as they come straight from their Maker's hands, learn to love all that is beautiful and true, and try to do the humblest work as perfectly as we find it is done in the seed-box or fruit of the little Urn Moss.

I must now say 'good-bye,' as this is the end of my last lecture, but before I do so I will give each of you the little pamphlet I promised, and thank you for your kind letters and the pressed leaves and flowers they contained, which gave me the greatest pleasure. After all the information you have gained I trust you will be able to raise plants in your homes and bring a small window-box or some little plant to the School Board Flower Show that is to take place in July.

[1] *Dangers to Health in our Houses.*

FIG. 113.

Plants suitable for Town and Window Gardening, with directions how to rear them.

A great part of the information in this chapter was prepared by me in a pamphlet form, to present to the sixty children who regularly attended my Lectures for a whole year. I have classified the families at the end of the chapter in the same order that they are placed in the Kew Museums, with directions as to where the living plants which I mentioned are to be found, as I hope some day the children who heard my Lectures may visit Kew Gardens.

Cuttings.

Cuttings to be planted in May or August to October:—

Fuchsias	Heliotrope
Geraniums	Lobelia fulgens
Calceolarias	

Fuchsias require rich food, a great deal of water while they are growing, but none during the winter months, when they have no leaves and are resting themselves. Directly they begin to work, their leaf-buds swell, and you must give them some water. Geraniums do not like rich food, but they must have a little water all the year round; they do not require so much water as the Fuchsia does, even in the summer. Should you wish to transplant a Geranium you have raised from a cutting into a window-box, put it, pot and all, and cover it with earth, because when Geraniums are removed from a pot into the earth they spread out their roots, suck up a great deal of water, make wood and foliage, but very few *flowers*.

Hints about Bulbs, and how to plant them.

Bulbs to be set in October, November, and December:—

Hyacinths	Narcissus
Tulips	Crocuses
Jonquils	Daffodils

Bulbs.—First cover the bottom of either a window-box or flower-pot about one-third its depth with pieces of an old

flower-pot, or any kind of broken china, oyster-shells, or cinders will do; because these things will prevent the earth from filling up the holes made at the bottom of the box to let the water or rain run out. Gardeners call these pieces of china, &c., 'drainage.' The holes at the bottom also let fresh air pass up to the roots, make the earth sweet, and prevent it from getting mouldy. Bulbs like very dainty food. After you have put in the drainage, place earth and sand over it, mixed together in equal quantities—powdered scouring stones or any clean sand will do—sprinkle clean *dry* sand for the bulb to rest on, and plant it about two inches deep in the earth. The best earth is got from under a hedge. November is quite late enough to plant bulbs. Water them when planted, but do not put them in the dark until the top of the soil is rather dry (say twelve hours after). Then put them where they have no sunshine, or the leaves grow first, eat up the food, and then no roots can grow to suck up water, and the plant will die. A dark cellar is a good place for them. After a month or two they should be brought into a living room and be kept by the window where they can get plenty of sunlight.

How to choose bulbs.—Bulbous plants, except Polyanthus, Narcissus, and Yellow Jonquils, should not flower every year; they require a year's rest. The leaves of a good bulb that has had a year's rest will lie fast together. If the leaves look open at the top part, where the young plant grows, the bulb is not in a proper state to plant. Do not give your bulbs too much water. Water them about once a fortnight; but if the bulb is very dry, once a week. Soot or manure must not touch a bulb; but manure-water is said to make the plants thrive very well. Manure-water is made by pouring water over either cow-dung or soot. When the manure has settled to the bottom, the water is ready for use.

Plants suitable for Borders.

Lobelia compacta	Perennial	March to May.
Golden Feather or Feverfew	"	"
Ivy	" (Cuttings)	Any time. Spring and autumn are the best.

Ivy makes very pretty borders, as it can be made to creep along the earth, just as it creeps up a wall, by sending out little roots from the stem to fasten itself to the soil. In the public gardens in Paris bright beds of flowers are often surrounded by borders of Ivy, twenty inches wide. Court-yards, walls, and all ugly places are covered by it. Wire screens over which Ivy has been trained are used in Paris drawing-rooms. In a porter's lodge near Paris Ivy has been trained to grow over a mantel-piece. I hear that a lady who lives in London has some small-leaved Ivy growing round a wooden picture-frame in her drawing-room. The Ivy is planted in a little wooden trough under the frame, in which flowers are growing. The Irish Ivy grows the quickest, and is said to thrive best in a town. The small variegated Ivy clings the fastest, and, some gardeners tell us, bears smoke very well.

I have often found that Ivy does not grow because it is not properly planted. Cuttings of two or three varieties do well planted thickly together, under a wall for instance, in the autumn. A great many put near together seem to thrive by sheltering each other. By the following spring they will have taken root, but not before, as Ivy dwells, and does not grow quickly. When it has fairly begun to grow it will find its own way to the wall, and creep up in search of light and air. People sometimes think they must show it the way it must go, and nail the stem of the cutting to a wall directly after it is planted; by this means the poor little plant is killed. Ivy will not creep along the earth unless it is *forced* to do so. Gardeners are obliged to fasten the stems down on to the ground by pegs, when they wish to form beds of Ivy. Cuttings of Ivy planted in pots in the autumn can be transplanted into wooden boxes in the spring, to cover the front, or to creep over an arch.

Climbing Plants for covering Walls and Trellises.

Ivy	Perennial (a Cutting)	At any time.
Virginian Creeper	"	Spring or autumn.
Everlasting Pea	"	"
Clematis montana	"	"

Plants for Areas.

Aucuba japonica. Virginian Creeper.
Ivy, if the area be large and light.

Plant a cutting of the Virginian Creeper in the autumn, just as you would plant any other cutting. If the plant is to grow in an area, remove a flag, dig a deep hole, and at the bottom of it put plenty of pieces of broken china or cinders; then cover this drainage with moss and earth full of very fine roots, such as you get from under a hedge, and mix it with the same quantity of clean dry sand. The first tender young roots of the cutting will soon be able to push themselves through this light open soil, and the air will pass through, because the sand and old roots or fibres prevent the earth from sticking together like a cake; the pieces of pot will allow rain or water to escape through the earth, and prevent it from growing mouldy and keep it sweet. If the cutting is planted in a wooden box, you must follow the same directions I have just given.

Rhododendrons and Ivy are said to thrive in some areas, but no plants bear smoke and want of light so well as the Aucuba Japonica and the Virginian Creeper; the latter is able to climb up any wall.

The following *Climbing Plants*, suitable for covering the front of window-boxes, twining round a cord, up the side and across a window, can be raised from seeds :—

Convolvulus major (Bindweed)	Seeds	April to May.
Sweet Pea	Seeds	„ „
Great Nasturtium	„	„ „

Plants to be raised from Seeds.

Name.	Kind.	Month for Planting.
Mignonette	Annual (Seeds)	April to May.
Sweet William	Biennial (Seeds)	„ „

Seeds should be sown in dry earth and dry weather, and watered directly after they have been set. The names of the seeds ought to be written on sticks. Seeds of climbing plants should be set in a ring, and a stick for them to climb

up should be placed in the centre. Seeds do best in a garden or set in a flower-pot, out of which they can be picked young,

FIG. 114.

and transplanted into a window-box, except the seeds of climbing plants, such as Sweet Pea, Convolvulus, and Nasturtium,

which creep up the side of a window, or cover the front of a box, or creep so as to form an arch to the box.

Fresh seeds grow best and quickest. There are some curious exceptions, such as the seeds of the Aucuba, that sometimes come up in three months, and at other times will not come up for two years.

The most suitable plants for growing in window-boxes are cuttings, bulbs, and roots.

Plants for Skylights.

The picture (fig. 114) is taken from a photograph of plants that have been living for the last three years under a skylight, at the top of the stairs of St. Andrew's Chambers, Leeds. The hanging wire basket was filled with Moss and Ferns gathered in a neighbouring wood. The creeping plant sometimes called Mother-of-thousands, or Toad-flax (*Linaria Cymbalaria*), grows between stones in walls. This plant is flourishing by one of the Leeds canals. The Ferns, I am told, are allowed to die down in the winter. The earth is kept moist by slightly watering about twice a week.

FIG. 115.

Linaria Cymbalaria, Mother-of-thousands.

Plants for Baskets.

Mother-of-thousands (*Linaria Cymbalaria*).
Musk, Aaron's-beard, Irish Ivy, and the small variegated kind.
House-leeks.

Flower-baskets must not be suspended in rooms where gas is used, because the air at the top of the room becomes so very bad that the plants are poisoned. Flower-baskets are very easily made with a piece of iron-wire. They look pretty in a porch, passage, or verandah. A flower-pot saucer with a hole must be placed in the basket to contain the drainage and soil. The saucer will be hidden when the basket is well lined with Moss.

Foliage Plants for a Room in Winter.

Dracænas, *Begonias* (members of the Lily family and of the *Begoniaceæ*).—These plants bear beautiful large leaves, but very small flowers; they are therefore called 'foliage plants.' The leaves are often beautifully coloured. These plants come from the colonies, where rain seldom falls. When rain does fall, these plants store up a good quantity in their leaves and stems, which they live on until the rain comes again. When plants like these are made to live in the dry air of our sitting rooms, they require a little water occasionally. They require much less care than flowering plants, and look quite as beautiful. All plants suffer, even more than human beings, from hot rooms at night lighted by gas; because they are accustomed, when living naturally out of doors, to be cooler at night than day, and to receive the dew which constantly falls in hot countries in the evening.

Aucuba Japonica.—During the winter an Aucuba has flourished on our drawing-room table and been very much admired. I have washed the leaves directly they looked dusty, and given the plant water about every ten days when the earth looked dry, or if the pot sounded hollow when tapped.

Mr. A. Clapham tells me that a cutting of an Aucuba strikes very quickly in a glass or stone bottle kept filled with water and placed in a *warm* room. When the roots are formed the cutting can be planted either in a flower-pot or in a garden.

Foliage Plants of Carrot Leaves.—Cut off about an inch from the top of a middle-sized carrot, where the leaves grew in the summer, called the 'crown;' wrap some green moss round this piece of Carrot, so that the crown just peeps through the Moss; then put it into a saucer or any kind of pot that is two-thirds filled with wet sand, fill up the edges of the pot with moss, place the Carrot in a dark, warm cupboard for a short time until it begins to grow; then bring it out into the room and put where it can get light. Do not give the plant water until the sand and moss become rather dry.

Canary Plant raised from the canary seeds upon which

birds are fed. Take a saucer, or any pot, and fill it about two-thirds with cold water; sprinkle some Canary seed on the top of the water until the water is well covered. The seeds will not sink if they are sprinkled very gently. Place the saucer in a dark, warm cupboard; let it remain there until the seeds have become a pink colour; then remove the saucer, and place it in a warm room, where it has light, and you will find the little pink plant will soon become a lovely green, and form a very pretty ornament for a sitting room.

Cheap Fern Cases, and how to make them.—Take one of those deep saucers, in which flower-pots stand, put a few cinders at the bottom; then cover them with a very little earth mixed with clean sand (not sea sand, because that is salt) over the bottom of the saucer; then place some rough pieces of stone or brick round the edge of the saucer, and some pieces of stone in the centre, to look like a little rockery. Very tiny seedling Ferns can be planted between the stones, or you may get a Fern leaf that has ripe seeds or spores on the under side or edge, and shake or scrape them off on to a piece of white paper; mix a pinch of fine earth or sand with the seeds, and shake the paper with the seeds over the stones and earth. The danger is that you will set too many seeds: Fern seeds are so small and fine that a great many go into a little space. Put a glass over the stones, and then fill up the outside space between the glass and the saucer with green Moss. When you give the Ferns water, do not take off the glass, only pour some water over the glass, and it will then wet the Moss, and the water will get under the glass. Do not give the Ferns any more water until they look as if they were fading; if you keep the glass always over the ferns, they do not lose much of the water that you first put in. There should be a very small hole at the top of the glass, to ventilate the air inside, and allow oxygen to enter. The only way to keep Ferns and all kinds of plants small is to starve them. If the saucer was filled with earth, and a great deal of water was given, the Ferns would soon grow too big for the case. You must also take care not to let a Fern leaf touch the glass. Keep the Ferns in the middle of the saucer.

Graft on wild stocks in March or the beginning of April, when the Sap is rising.

Graft garden Rose on to stem of wild Dog Rose found in hedges.

Geraniums can be grafted at any time, as they are evergreens.

Wild Flowers.

Fresh air is so necessary to wild flowers that it is almost impossible to keep them alive indoors. The only plant that

FIG. 116.

Wood Sorrel asleep.

I have found continue to flourish and be healthy in a drawing-room is the Wood Sorrel, commonly called *Sleeping Betty*, as

the leaves of this little plant shut up and fall asleep as the night comes on. I had the Wood Sorrel I have just mentioned photographed when it was awake, to put beside the picture of it when sleeping.

FIG. 117.

Wood Sorrel (or Sleeping Betty) awake.

Plants that will not grow in Smoky Towns.

Cowslips	Snowdrops
Primroses	Violets

Meaning of some words used by Gardeners.

A compost means earth formed in hedges where a great many plants grow, full of very fine woody fibrous roots that will burn. This earth is therefore said to be *friable.* This earth suits nearly every plant if mixed with about half the quantity of clean dry sand of any kind.

Loam means just the top part of the earth, in which no plants but grass have grown before.

Leaf Mould is made of dead leaves mixed with a little earth.

Herbaceous Plants.—A plant is called *herbaceous* when the stem and branches that rise above the ground die down in the winter, and only the roots remain to send up new stem and branches in the spring. Plants are also said to be herbaceous when they contrive to live above ground summer and winter, but their stems and branches do not contain hard wood, such as is found in the Oak. A Geranium and Fuchsia are herbaceous. Gardeners place plants out of doors as much as possible to harden them; because light and plenty of fresh air help the leaves to make wood and harden the stems.

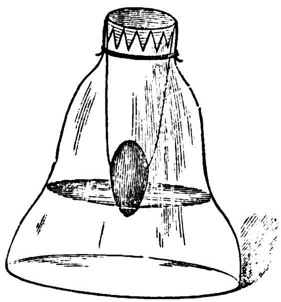
Foliage Plants raised from Seeds.

You will find great interest in rearing little foliage plants for the winter from seeds, by placing them in water in either a glass gum bottle, saucer, or any kind of pot. In one of the pictures below (fig. 119) you will see a tiny plant or Oak-tree, standing in a gum bottle, that has grown out of the acorn in the water. Ever since the acorn has been in the water, the little plant inside has been feeding on the food that was stored up ready for it in the two thick seedling leaves which swelled out the seed-skins, and are still to be seen fastened to the stem. The long tap-root, which the stem has sent out to suck up water for the leaves, has twisted round and round, because there was no earth through which it could push its way. You must read the directions that are given, and then you will know exactly how to place seeds of any kind so that they will grow up into small plants. I was much pleased to see these pictures, &c., last week in a newspaper called *The Queen*, and to be allowed to give the following directions and the pictures.

Timber trees as indoor ornaments.—Underneath the boughs of the Oak may be found at the present season (November) multitudes of ripe acorns that have fallen amidst the decaying leaves. These may, with the expenditure of an amount of trouble that is not worth a thought, be made to furnish most interesting and pleasing ornaments for our sitting rooms—their great attraction being that, living and growing, they are ever fresh and ever new. The simple process is as follows:

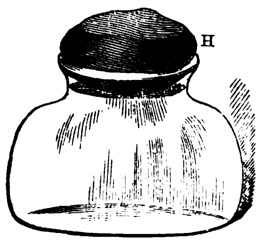
select a large, well-grown acorn, and by the aid of a very stout needle run a strong thread through it, in such a manner that the acorn shall hang with the pointed end straight downwards. Now put the acorn so threaded in a clear glass bottle (for this purpose an empty gum bottle answers very well), place the two ends of thread over the opposite sides of the neck, and secure them by wrapping a few turns of fine

FIG. 118.



Acorn arranged for growing.

FIG. 120.



H, horse-chestnut placed on water for germination.

FIG. 119.

Young Oak grown in a gum-bottle. A, two seedling leaves shut up in the seed; B, tap-root.

thread or string around the neck, and fix the turns by tying the ends together. This done, pull upon the ends of the thread that pierces the acorn until the latter hangs fairly point downwards in the very centre of the bottle. Now pour in a little water until it just reaches, and no more, the point of the acorn. Then cut a small piece of card, with vandyked

edges, which can be turned down so as to form a loose cover. The whole operation is complete, and the result is shown in fig. 118.

If the acorn so prepared be kept in an ordinary sitting room, or placed on the mantelshelf, it will be seen that after a few days, more or less, dependent on the warmth of the room, the shell will open at the point, and a white radicle or long root will grow downwards into the water. This root will go on elongating for weeks. In a state of nature it would become the tap-root of the Oak; but, as in its glassy prison it cannot obey the attraction of the earth, it coils round and round the inner side of the glass until a foot or more is packed away in the little bottle, and small rootlets grow forth profusely from its sides. At last the upper coverings of the acorn split, and the plumule, in the form of a little green stem, forces its way out, bearing delicate fairy-like leaves of the most exquisitely tender green. These will grow with vigour, borne on a straight stem; the card covering will then have to be perforated to allow the little timber tree to grow out into the open air, and assume the appearance shown in fig. 119.

The interest excited by the growth of an acorn in this manner is very great. The little tree is, as it were, a child of your own rearing. All its requirements have been fulfilled by your own hands—the gardener has had nothing whatever to do with it; the little glass forcing house is all your own. You can set going a dozen or more if you like, and the growth of a forest of fairy Oaks will gladden your eyes, even whilst the keen blasts from the icy north have checked all progress in the parent trees.

Through the long winter the tender leaves continue to appear. When spring returns with the revolving year the growth becomes more vigorous; through the long summer and the ensuing winter the little Oak flourishes on, the leaves finding sufficient nourishment in the solid lobes of the seed. The Oak has become an evergreen; and, if at the end of the second winter you plant it, may perchance flourish for a thousand years—

A thing of beauty and a joy for ever.

The seeds of other timber trees may be used in a similar manner, with such modifications of the arrangements as are required by their size and form.

Fig. 120 shows a Horse Chestnut placed in the neck of a bottle just touching the surface of the water, in which position it will germinate freely, though not quite so rapidly as the acorn.

When to Water Plants.

Rules about the best time to water plants.—Never give plants water in the middle of a summer's day, when the sun is shining upon them, because the hot leaves will make the water so hot that it will scald and blister them.

Boxes suitable for Window Gardens.

Round cheese-boxes, powder-blue boxes, fancy soap-boxes, or any similar moderate-sized boxes, make good window-gardens, and can be bought at any grocer's shop for a few pence. They look pretty painted green. Take care not to buy very large boxes, as they are so heavy to move. Window-boxes and pots should never be placed down flat, as then no fresh air can pass up through the holes at the bottom of the box or pot, unless the stand on which they are placed is made of rails like a plate-rack. In the greenhouses at Kew I noticed that cockle-shells were broken up into small pieces and placed under the pots that stood on flat shelves; cockle-shells can easily be got, and look very clean and pretty. When pots are allowed to stand in saucers filled with water, air cannot possibly get to the roots, and the earth about them may therefore become mouldy. Do not buy painted flower-pots, because the paint fills up the holes and prevents air from passing through the pot into the earth. I think a clean flower-pot always looks well.

Trees suitable for Towns.

Western Plane (*Platanaceæ*).
Robinia Tree (family *Leguminosæ*).
Horse Chestnut (*Sapindaceæ*).

As it is now well known that the air we breathe becomes much more pure where trees are growing, it is our duty to find out the kind of trees that will live in smoky towns like *Leeds*, and plant them in some of our streets and in every open space where children can play, and their fathers and mothers spend their summer evenings, as they do in Paris. A book has lately been written which gives us the names of the trees and shrubs that will grow and be healthy in the worst parts of large cities, such as Paris and London. Mr. Robinson, who wrote this book, assures us that our English climate is a better one for rearing plants than Paris, and that it is owing to our ignorance and want of care for the health and comfort of the people, that our large towns are such desolate and unhealthy places.

The Paris authorities do not allow squares to be shut up as they are in London and other large towns. Every open space is planted with trees, and the ground covered with gravel, upon which the children can play. French children never think of injuring the smallest plant, so that it is unnecessary to protect the squares with high railings and spikes on the top. At about four o'clock in the afternoon a square in the most populous part of Paris is so crowded with working people and their children, that it is almost impossible to pass through it. Before the Emperor Napoleon had this public garden laid out, the air in this part of Paris was quite poisonous.

Some of the most crowded streets in Paris have long rows of trees planted on the pavements. Each tree has an open grating round the bottom of the trunks, to allow rain and fresh air to enter, and also to prevent the earth round them from becoming hard by the constant pressure of the foot passengers.

I will now tell you something about the trees that Mr. Robinson says bear smoke better than any others—the Plane,

Sycamore, and Robinia; and show you figures of their leaves and fruit.

The Western Plane tree is a native of America, in the Far West, and is therefore called the Western Plane. It flourishes in all parts of the world, but the finest Planes are now growing in the most crowded parts of London, where,

FIG. 121.

Western Plane Tree. A, fruit.

Mr. Robinson says, none of the care is taken of them that is bestowed on those that grow in Paris. Near St. Paul's Cathedral, in Stationers' Hall Court, there may be seen a noble Plane tree, flourishing as well, it is said, as if it were in its native forest!

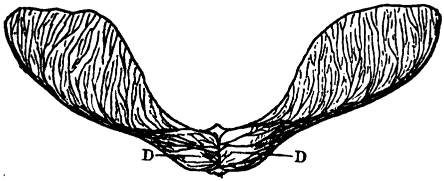
Having heard so much of the trees of Paris, I determined I would examine them well when I went there last January and in the summer. I recognised the Plane tree directly, though it was winter time, by the little ball-like tassels that hung from the branches; these balls are the fruit, and contain the seeds.

Even in winter the Plane tree looks well, with its fine form and hanging tassels. In the summer it is rather difficult to tell a Plane from a Maple or Sycamore, as their leaves

are very similar, but the fruit is very unlike, as you will see by fig. 122.

In Paris large trees are lifted out of the earth and carried

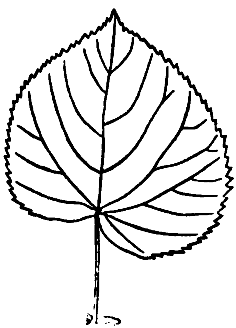
FIG. 122.



Sycamore Fruit. D, place where the seeds lie.

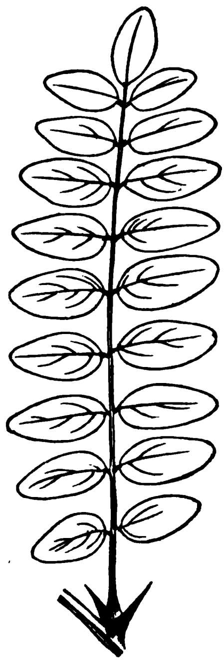
great distances, to be replanted. The Plane is a tree that bears transplanting extremely well.

FIG. 123.



Leaf of the Lime Tree.

FIG. 124.



Robinia Leaf.

When you visit London you must take a walk down the Thames Embankment, a beautiful promenade, where rows of young Plane trees have very lately been planted. You must also remember to look at Cleopatra's Needle, which I told you about in the last Lecture.

Trees that lose their leaves and put on a clean dress every year grow best in smoky air. It is a waste of money, Mr. Robinson says, to try and make evergreens grow in smoky

FIG. 125.

Flower branch of the Horse-Chestnut Tree.

and impure air. Ivy, and our old friend the *Aucuba japonica*, are nearly the only evergreens that thrive well in such places. Both these plants will even grow under trees, because they are not injured by what drips from them.

I have searched in vain for a Plane tree in Leeds, or in the neighbourhood; nevertheless, we must hope soon to see them flourishing in our streets, and in the playgrounds belonging to

the Leeds School Board, which have lately been thrown open to the public. I should also like to see the playground covered with clean gravel instead of cinders, and the walls hidden with Ivy. Lime trees, unfortunately, have always been considered the best for smoky towns, but Mr. Robinson says they are the worst of all trees for cities. The leaves fade very early, and hang on to the branches in a miserable way, when the foliage of the Plane and Robinia looks bright and green, as I saw when in Paris. Limes do better in a park, but are quite unsuitable for streets or small town gardens, where they are so generally planted. The bark of both the Lime and Plane peels off at a certain part of the year. I noticed that the Horse-Chestnut tree did very well in Paris. I must mention that the Black Poplar flourishes in the most smoky part of Leeds, in Meadow Lane. I wish I could induce members of Town Councils to read 'Parks and Promenades about Paris,' because I feel sure they would then have some hope of being able to improve our English towns.

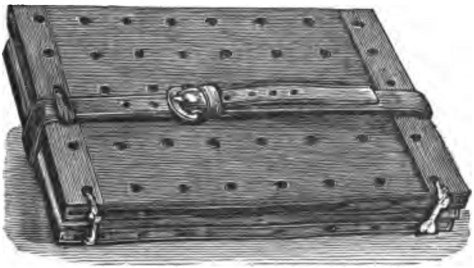
Directions how to form a small Collection of Dried Plants, called a 'Herbarium.'

If you wish to make a collection of wild plants, and find out to what class and family they belong, you must gather a stem on which there are leaves and a flower. Fruit and seeds are not often necessary. To preserve plants well, you must try to do the following things:—Drive out all the water or sap from their stems, and make them dry, or they will grow mouldy and soon decay; preserve the colour of the flowers, and place each specimen so that the stem, leaves, and flowers lie in a natural position.

It is useless to try and press a plant if it has been crumpled up and kept until it is soft. The best plan is to put the plant as soon as possible between sheets of thick blotting-paper, sold for the purpose, and then place the sheets under a heavy book or weight of some kind, to press out the juice. The sheets of blotting-paper should have a hard cover, with holes to let the damp air escape from the plants and dry air pass in. The more quickly they dry, the brighter the colours will be.

Now I will show you a little pressing-case, which I had made for myself, and some specimens lying between the sheets of paper.

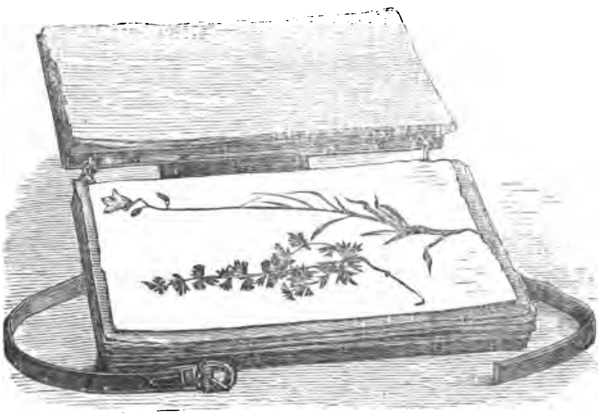
FIG. 126.



Wooden Case for drying plants.

We will first examine the outside of the case. It is made, you will see, of two pieces of flat wood, with several holes bored through it for the damp air to escape ; two of the sides

FIG. 127.



Wooden Case open.

are fastened together by pieces of cord run through the holes at each corner, and so form a kind of book cover to the sheets. A strap passes across it, and through the loop made at the

side, to keep it in its place; this strap can be pulled very tight, and easily opened. I fasten this case round my waist when I go for a country walk, gather a few plants, put them in my large pocket, and when a seat comes in my way I sit down, and put the fresh plants between my blotting-paper; and so have nothing to do when I return home but to put the case under a weight. I look at the plants in a few days to see if they lie straight, and whether the paper is wet; if so, I put a fresh piece to suck up the moisture, and just let them remain until I think they are fit to fasten on to a sheet of cardboard with a little gum. I have lately seen a beautiful collection of dried ferns and flowering plants prepared in this way placed in shallow drawers, divided into compartments of different sizes. As the drawers belonged to a piece of furniture that stood in a sitting-room, the plants were kept perfectly dry. Very thick stems are slit up, and laid flat. You must take care not to put too great a weight on a delicate plant, or it will be crushed. It is always best to begin with a small weight, and let the next be heavier. I am sure you will be able to make a case for yourselves like mine for very little money.

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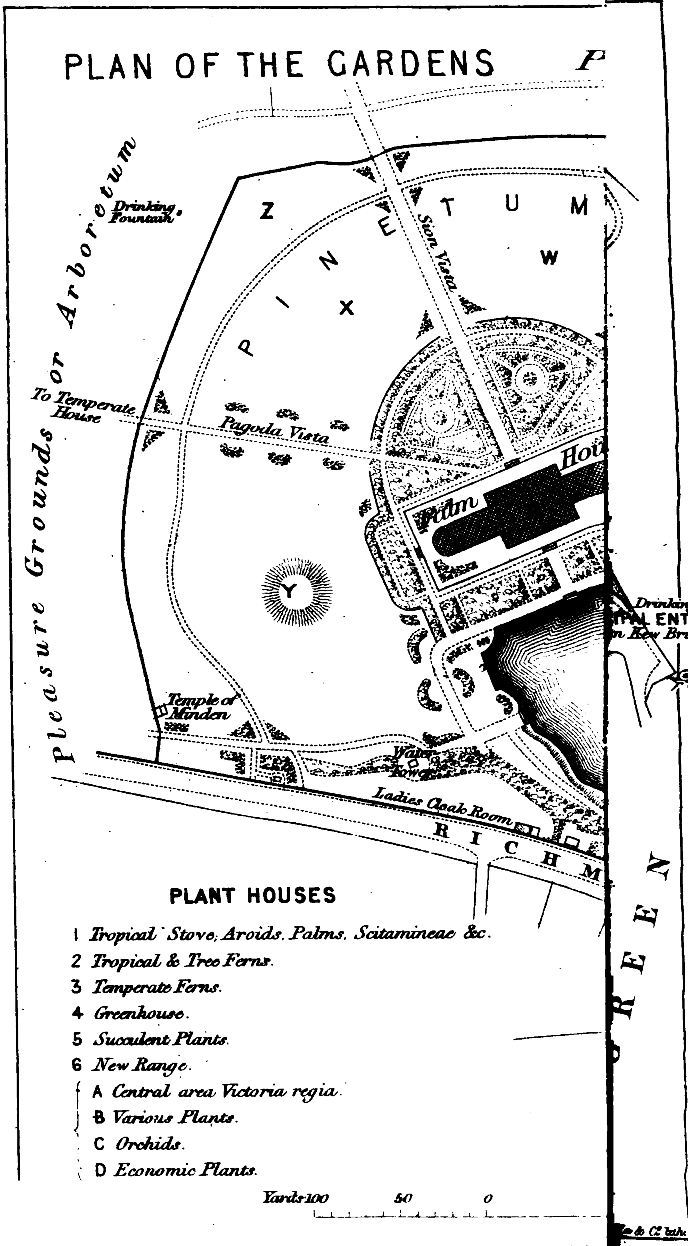

PLAN OF THE GARDENS
P
Pleasure Grounds or Arboretum
Drinking Fountain
Z
PINETUM
W
X
Y
Sion Vista
To Temperate House
Pagoda Vista
Palm House
Drinking Fountai
PAL ENTRANCE
n Kew Brid e)
Temple of Minden
Water Tower
Ladies Cloak Room
RICHM
GREEN
PLANT HOUSES
1 Tropical Stove, Aroids, Palms, Scitamineae &c.
2 Tropical & Tree Ferns.
3 Temperate Ferns.
4 Greenhouse.
5 Succulent Plants.
6 New Range.
A Central area Victoria regia.
B Various Plants.
C Orchids.
D Economic Plants.
Yards 100
50
0
& Co. lith.

ROYAL GARDENS, KEW.[1]

I TRUST the following directions will enable you to find the living plants I have described during my lectures, and the substances each family produces. The Grounds open to the public are the Botanical Gardens and a Pleasure Ground adjoining, called an *Arboretum*. The principal entrance from Kew Green leads into the Botanical Gardens, in which stand three buildings called Museums, fitted up with glass cases filled with the substances each family of plants produces, called economic, such as foods, articles for manufacturing into clothing materials, specimens of wood, showing how beautifully many of them are marked in their natural state.

Museum No. II. stands in a piece of ground called the Herbaceous Ground. In this ground the families of plants are arranged in proper order, some of the larger families occupying several beds. The Exogenous plants are thus separated from the Endogens and Grasses. On a wall in the Herbaceous Ground you will find the Green Rose (*Rose Verte*), called by this name because all the organs of the flower—sepals, petals, and stamens—have the appearance of green leaves, showing that the parts of flowers, though for the most part highly coloured, are only transformed leaves.

In the Arboretum, or Pleasure Ground, there is a very large Greenhouse, called the Winter Garden, where most curious trees and shrubs grow during the winter, brought from Australia, New Zealand, Japan—countries where the climates are more temperate than ours. The following are the names of trees I have mentioned: Eucalyptus trees of different kinds, Acacias, Pines, Palms, Laurels, Fuchsias, a large collection of plants from Japan, amongst which you will find the *Aucuba japonica*.

[1] These Gardens are called Royal Gardens because our Queen Victoria presented them to her people in 1840.

Herbarium.—The Herbarium at Kew contains the largest collection of dried plants in the world. This building is not immediately in the Gardens, but stands in its own grounds near Kew Green. The public can only gain admission by an order obtained from the Director.

There are six Greenhouses, besides the large Palm House and the Water-lily House near the Lake.

Greenhouse No. IV.—Many interesting climbing plants are to be seen growing up the rafters of this house, among them the wonderful climber I mentioned, called *Bignonia capreolata.*

Greenhouse No. V. is for Succulent plants, among which are the Prickly Pear, several species of Cactus, American Agaves, Dracænas. Among the climbing plants is the *Clematis.*

Greenhouse No. VI.—This house is built in the shape of the letter T and is divided into different compartments, closed by doors to prevent any draughts.

The central portion leads into a space where there is a large tank of water filled in the summer by a wonderful plant, *Victoria Regia*, that bears a most beautiful flower. The east wing contains a large collection of Fly-traps, Droseras, Pitcher plants, and Orchids of every kind. West wing—Plants that give us food, medicine, clothing, such as the Cotton Plant, Vine, &c. North wing—Foliage plants, Begonias, Heaths, Geraniums.

Palm House.—Contains a very large collection of Palm trees and other tropical plants. Those I have mentioned are Cocoanut Palm, Wax Palm, Date Palm, Cabbage Palm, Wine Palm (*Arenga saccharifera*).

Water-lily House.—A small house close to the large Palm House. This contains a large tank, chiefly filled in summer with the Papyrus (*Cyperus Papyrus*), which grows on the banks of the Nile, and has a triangular stem. The Sacred Lotus (*Nelumbium speciosum*), or the beautiful Lily of the Nile I have described, grows in the small water tanks which are placed in the corners of this house.

Greenhouse No. I.—Contains Tropical Plants.

Greenhouse No. II.—Tropical Ferns.

Greenhouse No. III.—Temperate Ferns.

In the Pleasure Grounds the following trees are to be found mentioned by me:—The Plane, Lime, Robinia, Horse-chestnut.

The three Museums I have mentioned are a short distance from these Glass Houses. In the first and largest Museum, No. I., exactly opposite the Palm House, all the substances from the Exogenous plants are placed. In the second, No. II., three minutes' walk from No. I., Endogens and the plants which do not bear flowers, such as Ferns, Mosses, Fungi, Seaweeds, &c. The third Museum, at the end of the Broad Walk that leads up to the Palm House, contains large specimens of wood, &c. On the Natal Sideboard, No. 22, there is a glazed case containing specimens of the wonderful dwarf plant called *Welwitschia mirabilis*, because it was discovered by Dr. Welwitsch, in 1859, on a sandy plateau in South-west Tropical Africa. It grows in a hard stony soil where little or no rain falls. It lives for one hundred years with only the two large seedling leaves which come out of the seed, become green, and continue to work during the whole life of the plant. These leaves lie flat upon the ground, and are about six feet long. I told you that these seedling leaves do not work, but die away when the young plant has used up the food they contained, and this is nearly always the case.

I hope you will look at a wax model of the Egyptian Lotus Flower I told you was called the 'Lily of the Nile;' it is placed in the top room of the Museum No. I., in Case 2; inside the case is written *Nelumbiaceæ*. The seeds, called 'Sacred Beans,' are to be seen buried in the dry fruit, which has the form of a top.

Classification as at Kew.

You will find that I have given you the English and Latin family names of the Plants in the following classification; also the English names of the Plants which belong to these families, and the chief substances we get from them.

An 'Order' means the same thing as a 'Family.'

Before you study the following list of plants, and the names of the families to which they belong, I will try and explain the way in which botanists now discover how plants are related to each other, and arrange them into classes, groups, families, &c. In 1778, Linnæus, a distinguished botanist, divided all plants into 24 classes, and found out to which of these classes a plant belonged, by the number of stamens the flower possessed. Botanists, in these days, first divide plants into two classes: the plants which bear flowers belong to the first class, and those that do not bear flowers, such as Ferns, Mosses, and Fungi, into the second class (pages 59, 60). They examine the flowers with a microscope, and find out how their organs are placed on the flower stalk or stem, and put all the flowers that are made on the same plan together in groups.

Plants which belong to the same group are again divided into families; each member of the same family has its flowers, seeds, stem, and leaves, arranged on the same plan, and often contain the same principle: many of the Rose family, for example, possess the same poison—prussic acid, and the flowers are all made on the same plan.

Every family includes a great many different kinds of plants; for instance, Apples (*Pyrus*), and Cherries (*Prunus*), are members of the Rose family (*Rosaceæ*). Each of these divisions is called a genus. No cultivation can change an Apple into a Pear or a Cherry. Each genus is divided into species; the Siberian Crab is one. No cultivation will change its nature; therefore it is called a species. Species are again divided into varieties—that means a plant varies its colour and shape when it is cultivated; for instance, there are many different kinds of Apples, and a Double Rose is a variety of the Wild Rose; if you plant it in a hedge, it will return to its natural state, and become single and a Wild Rose.

The first great division, called Exogens or Dicotyledons, is again divided into four groups.

The first group is called *Thalamifloræ*, and contains all the flowers that are most perfectly made; that means they have every organ a flower can have, and that these organs stand quite distinct from one another. For instance, the leaves

that form the calyx and corolla are separate, and can be pulled off the stem or receptacle one by one; the stamens can also be taken off separately, as they grow independently of each other round a part of the stem that lies under the pistils; the pistils also stand alone, and can be taken off separately.

The following are only thirteen of the most important families that belong to the group *Thalamifloræ*. Dried specimens of the substances we get from them are placed in cases in MUSEUM No. 1, on the *top floor*. Each case is numbered distinctly on the *outside*. The name of the family is placed *inside* the case.

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 1. Ranunculus, or Crowfoot family.	Ranunculaceæ	Buttercup, clematis, monkshood or aconitum (sometimes mistaken for horse-radish), peony, hellebore, clematis or traveller's joy, anemone, hepatica, larkspur, and Christmas rose. A poison called aconite is found in some members of this family.
CASE 2. Barberry family	Berberidaceæ	A yellow dye is got from the root and bark of the common barberry, and the fruit is preserved.
Water-bean family	Nelumbiaceæ	The lotus (*Nelumbium speciosum*). This plant is at the present time held sacred by the Egyptians; the seeds and stem contain much starch, and are used as food in India and China. The seeds were formerly called 'sacred beans.' In this Case is a wax model of the lotus flower, called the Lily of the Nile, also the fruit and seeds.
CASE 3. Poppy family	Papaveraceæ	Poppy. All the members of this family contain a similar poisonous principle to opium, which is a juice drawn out of the seed-vessel, or fruit, of *Papaver somniferum*, which looks something like a hard, dried apple, called a poppy-head. You can see little knives that are thrust into the fruit to make holes for the opium to run out, used by the Indians. It is a curious fact that there is no poison in the seeds, but a great deal of oil that has no colour and dries very quickly, so that a great deal is used to mix with varnishes.

MUSEUM NO. 1.—TOP FLOOR—*continued.*

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 4. Crucifer, or Turnip family.	Cruciferæ	Turnips, cabbage, mustard, cress, radish, cauliflower, horse-radish, sea-kale, scurvy-grass, stock, shepherd's-purse, and wallflower. All the members of this family are wholesome.
CASE 5. Cistus family	Cistaceæ	Gum cistus, rock rose.
Violet family	Violaceæ	Sweet violet, heartsease.
Chickweed family	Caryophyllaceæ	Pink, carnation, sweet-william, chickweed, ragged robin, Nottingham catchfly (*Silene nutans*).
Mignonette family	Resedaceæ	Mignonette.
CASE 7. Tutsan family, or St. John's wort.	Hypericaceæ	St. John's wort, tutsan.
CASE 8. Tea or Camellia family.	Ternströmiaceæ	The tea plant. You can see the colouring matters that are frequently used to make the leaves of this plant into green tea. Camellias are beautiful greenhouse plants. The leaves of some kind of camellia have been used as tea. Tea comes from a different plant (*Thea chinensis*).
CASE 9. Mallow family	Malvaceæ	Cotton plant. We get the cotton that is spun into calico from a white hairy substance that covers and protects the seeds inside the fruit; in this Case you can see the ripe fruit or seed-vessel bursting open, and the white cotton round the seed, looking like a ball of snow, pushing its way through the seed-vessel. You will find in Case 9 cotton materials from all parts of the world. The following are also members of the mallow family: hollyhock, marshmallow, &c.
CASE 11. Linden family	Tiliaceæ	Lime, or Linden tree. The bark is made into Russia matting. The wood of this tree is excellent for carving.

The following are twenty-five of the principal families belonging to the second group called *Calycifloræ*.

The flowers of this group have every organ. The leaves that form the calyx are always joined together, but those that form the corolla are quite separate. The stamens are not free; they grow fast on either the calyx or corolla.

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASES 11 & 12. Flax family .	Linaceæ . .	Linen is made from the fibre of the stalk of the common flax plant (*Linum usitatissimum*). In Case 11 you will see linseed oil, which is got from the skin that covers the seed, and linseed cake made from the crushed seed after the oil is taken out of it. Look at the linen cloth used by the Egyptians to cover the dead.
CASE 13. Cranesbill family	Geraniaceæ .	Cranesbill, geraniums, pelargoniums. This family is celebrated for its beautiful flowers.
CASE 13. Indian cress family	Tropæoleæ .	Nasturtium (*Tropæolum majus*). The half-ripe fruit is preserved in vinegar and used instead of capers.
CASE 13. Wood-sorrel family	Oxalideæ . .	Wood-sorrel. Goes to sleep by closing its leaves at night.
CASES 15 & 16. Melia family .	Meliaceæ . .	Trees that grow in hot countries, they give us beautiful woods for furniture. Satin-wood is from a tree called *Chloroxylon Swietenia*. Mahogany from *Swietenia Mahagoni*. You can see in this case a model of a truck laden with mahogany, showing how it is carried from the forest to the rivers to be floated down to a port for shipment. For fifteen years a large trunk of a mahogany tree has been lying on the ground, because it is too heavy to be taken away.
CASE 17. Holly family .	Aquifoliaceæ .	Holly. Paraguay tea.
CASE 18. Spindle-tree family	Celastraceæ .	The spindle tree is the only member of this family that lives in Britain, and the fruit remains on the tree long after the leaves have fallen off, showing the seeds covered with a bright red pulp, called an *arillus*.
CASE 19. Buckthorn family	Rhamnaceæ .	Buckthorn, Christ's thorn.

MUSEUM No. 1.—TOP FLOOR—*continued.*

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 19. Vine family	Ampelideæ	All the members of the Vine family are climbers, and are natives of East India. There are a great many different sorts of grape vines—grapes that grow in England, from others we get raisins and currants which we put into puddings. The currants which we grow in our gardens belong to a different family. The Virginian creeper is one of the Vine family.
CASE 21. Maple family	Aceraceæ	Maple and sycamore tree (*Acer pseudo-platanus*). Latin name means 'false plane,' because the leaf so closely resembles that of the plane tree. Soft wood, used by turners to make bowls, and for carving. Sugar maple tree (*Acer saccharinum*) grows in the United States and Canada; 4 lbs. of sugar is made from one tree; a half-inch hole is made in the tree, and a spout is put in the hole, through which the sap runs that is boiled and made into sugar; the wood is used for cabinet work.
CASE 21. Soapwort family	Sapindaceæ	There is a soapy substance in some of the fruits of this family, and when put into water they make a good lather. Horse-chestnut tree (*Æsculus hippocastanum*); fruit given to feed horses, sheep, &c. The wood is soft and little used. The wood of the sweet chestnut tree is very hard and good; this tree belongs to the same family as the oak (*Corylaceæ*). In Case 87 you will find some specimens of this wood.
CASES 22 TO 33. Peaflower family	Leguminosæ	Pea, bean, lentil, acacia, robinia tree—suitable for towns, laburnum (fruit of the laburnum is poisonous), lupin, broom, gorse. Lentils ground into flour and called *Revalenta arabica.* Rosewood, used for furniture, from trees that grow in Brazil and Central America.
CASES 33 TO 36. Rose family	Rosaceæ	Rose tree, apple, pear, peach, plum, apricot, sweetbriar, whitethorn, blackthorn (in the blackthorn the flowers

MUSEUM NO. 1.—TOP FLOOR—*continued.*

English Name of Family	Latin Name of Family	Members of these Families and their Products
		come before the leaves), sloe, mountain ash, cherry, strawberry, blackberry, *Spiræa*, Portugal laurel, common laurel—this laurel and bitter almonds contain a great deal of poison, called prussic acid, which is to be found in every member of the Rose family. The common and Portugal laurels do not belong to the true Laurel family (Case 70).

MUSEUM NO. 1.—MIDDLE FLOOR.

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 37. House-leek family	Crassulaceæ .	House leek, stone crop which grows on stone walls and roofs of cottages.
CASE 37. Sundew family .	Droseraceæ .	Sundew (*Drosereæ*).
CASE 37. Gooseberry and currant family.	Saxifragaceæ .	Gooseberry, currant, London-pride, grass of Parnassus, Aaron's beard.
CASES 38 TO 43. Myrtle family .	Myrtaceæ . .	Cloves and allspice are some of the substances we get from this family. All myrtles possess a delightful scented oil. The *Eucalyptus* trees are natives of Australia, and are amongst the largest trees in the world; they grow very rapidly and make very hard timber, almost as durable as the oak. It is said that there is a eucalyptus growing in Victoria that is nearly 500 feet high—above the height of St. Paul's.
CASE 43. Evening primrose family.	Onagraceæ .	Fuchsias, evening primrose, willow herb.
CASES 44 & 45. Gourd family .	Cucurbitaceæ .	Cucumbers, melons, vegetable-marrows, gourds. In these Cases will be seen the baskets and scrubbing-brushes made from gourds; and teapots, jugs and different utensils, drums and other musical instruments, and snuff-boxes, beautifully carved, are made from the fruit, when all the seeds have been taken out.

MUSEUM No. 1.—MIDDLE FLOOR—*continued.*

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 45. Indian fig family	Cactaceæ . .	Cochineal, Indian figs.
CASES 45 & 46. Umbellifer family	Umbelliferæ .	Parsley, hemlock, fennel, celery, carrot.
CASES 46 & 47. Ivy family .	Araliaceæ . .	Ivy.
CASE 47. Cornel family .	Cornaceæ . .	Japan laurel (*Aucuba japonica*).
CASE 47. Honeysuckle family.	Caprifoliaceæ .	Elder, honeysuckle.
CASES 47 TO 51. Peruvian bark family . .	Rubiaceæ . .	Madder, bedstraw, woodruff, Peruvian bark, quinine-yielding plants.

The following are seventeen of the principal families belonging to the third group, called *Corolliforæ.* The flowers that belong to this group have a calyx and corolla, but the leaves that make the corolla are all joined together at the base.

MUSEUM No. 1.—MIDDLE FLOOR.

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 51. Valerian family .	Valerianaceæ .	Valerian, corn salad.
CASE 51. Teazle family .	Dipsaceæ . .	The fuller's teazle (*Dipsacus fullonum*).
CASES 51 TO 53. Composite family	Compositæ .	Daisy, sunflower, everlasting flower, dandelion, chicory, Jerusalem artichokes, dahlia, chrysanthemum, asters.
CASES 53 & 54. Heath family .	Ericaceæ . .	Heaths, rhododendron, Alpine rose, kalmia, azalea, arbutus. This family is known by the holes or pores, placed at the extremities of the pollen-case, or anther, through which the pollen escapes. (*See page* 72.) The rhododendron attains the highest elevation

MUSEUM No. 1.—MIDDLE FLOOR—*continued.*

English Name of Family	Latin Name of Family	Members of these Families and their Products
		of any Alpine plant. Sir J. Hooker brought one of these plants from a height of 17,500 to 18,000 feet in the Eastern Himalayas.
CASE 54. Primrose family	Primulaceæ	Primrose, polyanthus, oxlip, cowslip, pimpernel.
CASES 57 & 58. Ebony family	Ebenaceæ	Ebony furnishes beautiful wood.
CASES 58 & 59. Olive family	Oleaceæ	Olive-ash tree, privet, lilac, jessamine.
CASES 59 & 60. Dogbane family	Apocynaceæ	Periwinkle.
CASE 61. Gentian family	Gentianeæ	Yellow gentian furnishes gentian roots—Swiss and German Alps. Blue gentian—mountains of Europe—bog-bean.
CASES 65 & 66. Trumpet - flower family.	Bignoniaceæ	Climbing plants, beautiful flowers, Bignonia Tweedieana and capreolata.
CASE 61. Bindweed family.	Convolvulaceæ	Convolvulus major, or bindweed, dodder.
CASES 61 TO 64. Nightshade family	Solanaceæ	Nightshade, deadly nightshade, belladonna, henbane, tomatoes, capsicums, tobacco, potatoes, thorn-apple.
CASES 64 & 65. Figwort family	Scrophulariaceæ	Calceolaria, foxglove, musk.
CASES 66 & 67. Acanthus family.	Acanthaceæ	Acanthus flower, much copied by the Greeks for ornamenting their buildings.
CASES 67 & 68. Vervain family	Verbenaceæ	Vervain, the teak tree of India—best wood for building ships, railway carriages, &c. Look at specimen of teak-wood, supposed to be 2,000 years old, from India.
CASE 68. Labiate family	Labiatæ	Salvia, sage, penny-royal, lavender, peppermint, marjoram, thyme, balm, dead nettle.

MUSEUM No. 1.—GROUND FLOOR.

The following are eleven of the principal families belonging to the fourth group, called *Incompletæ*, because the flowers

belonging to this group are incomplete—not perfect; they have no coloured corolla and sometimes no calyx; the stamens and pistils are sometimes separate, and grow either on the same tree, in different flowers, or on distinct trees that are often some distance away from each other, like the flowers of the Aucuba; a great many of our forest trees are made on this plan—the oak, willow, poplar, elm, plane, beech, and fir trees:—

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 70. Goosefoot family	Chenopodiaceæ	Beetroot. One ton of beetroot is said to afford 100 lbs. of raw sugar, 55 lbs. of refined sugar.
CASE 70. Laurel family	Lauraceæ	The sweet bay laurel, the only European tree belonging to this family; all the other trees grow in tropical countries. Cooks use the leaves of the sweet bay for flavouring custards.
CASE 76. Sandal-wood family.	Santalaceæ	Sandalwood, from trees of India and the Pacific Islands.
CASE 79. Pitcher-plant family.	Nepenthaceæ	Pitcher-plants.
Nettle family	Urticaceæ	Stinging-nettle (*Urtica dioica*). Parasol cover made of the fibre of this common nettle.
CASE 80. Hemp family	Cannabinaceæ	Hops, hemp.
CASE 83. Fig and mulberry family.	Moraceæ	Fig, mulberry, banyan tree.
CASES 85, 86, & 87. Elm family	Ulmaceæ	Elm trees.
Willow family	Salicaceæ	Sallows, poplars, osiers.
CASE 87. Nut and Hazel family.	Corylaceæ	Oak, beech, sweet-chestnut. This Case contains specimens of different woods.
CASE 92. Walnut family	Juglandaceæ	Walnut tree afforded the chief wood for making furniture before mahogany was introduced into England.
CASES 93 TO 100. Pine family	Coniferæ	Scotch fir, cedar, yew, larch, 'Wellingtonia gigantea.' From the pine family we get a great variety of wood known as deal, pine, &c., resin, turpentine, tar, &c., to be seen in the above Cases.

MUSEUM NO. 2.—UPPER FLOOR.

Endogens, or Monocotyledons, are divided into two groups.

GROUP 1.—The flowers that belong to this group are complete; the following eight families belong to this division:—

English Name of Family	Latin Name of Family	Members of these Families and their Products
CASE 2.		
Orchis family .	Orchidaceæ .	Orchids, vanilla.
CASE 8.		
Iris family .	Iridaceæ . .	Crocus, iris.
Amaryllis family	Amaryllidaceæ .	Narcissus, snowdrops, daffodils, agave.
CASE 9.		
Pine-apple family	Bromeliaceæ .	Pine-apple.
ROOMS 2 & 3.		
CASES 10 TO 35.		
Grass family .	Gramineæ . .	Bamboos (from which plant you will find a great many ornaments are made), rice, sugar cane, Indian corn.
ROOM 5.		
CASE 38.		
Lily family .	Liliaceæ . .	Lilies, onions, asparagus, tulip, hyacinth.
CASE 46.		
Arum family .	Araceæ . .	Arum, called 'lords and ladies,' or cuckoo pint.
CASE 47.		
Sedge family .	Cyperaceæ . . .	Bulrush, cotton-grass, sedge, papyrus. The Egyptians made their paper from the pith and stem of the papyrus.

MUSEUM NO. 2.—GROUND FLOOR.

English Name of Family	Latin Name of Family	Members of these Families and their Products
ROOMS 6 TO 8.		
CASES 49 TO 90.		
Palm family .	Palmaceæ . .	These Rooms are filled with the substances procured from different palm trees. These substances and the palm trees are too numerous to mention.

GROUP 2.—The plants of this group do not bear flowers. Ferns, mosses, fungi, lichens, and seaweed, called *Algæ*, belong to this class (page 61). The table-cases are filled with the substances obtained from them. If you look in one of the window recesses, you will see the vinegar plant, called the Mother of Vinegar. It is a fungus something like yeast.

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